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OAK RIDGE NATIONAL LABORATORY

MARTIN MARIETTA

Industrial Safety and Applied Health Physics Division Annual Report for 1982

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MANAGED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A05 Microfiche A01

ORNL-5962
Dist. Category UC-41

Contract No. W-7405-eng-26

INDUSTRIAL SAFETY AND APPLIED HEALTH PHYSICS DIVISION ANNUAL REPORT FOR 1982

Date Published: December 1983

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

Acknowledgements

The coordinators would like to acknowledge the IS&AHP staff members who performed the actual tasks of collecting data and performing analyses and the secretaries who typed the results. We would also like to thank the staff members of the Technical Publications Department, especially Ralph Sharpe, for their time, patience, and technical assistance in compiling this report.

Contents

1. Introduction

The Industrial Safety and Applied Health Physics (IS&AHP) Division has as its principal mission the protection of Oak Ridge National Laboratory (ORNL) employees and the environment surrounding ORNL. This mission includes responsibilities in the areas of radiation protection, occupational safety, and environmental management. The division's Health Physics Department is responsible for the evaluation and control of radiation and contamination hazards. This responsibility includes the acquiring, calibrating, and servicing of radiation-monitoring instruments; the operation of a personnel monitoring program for the evaluation of external and internal radiation exposures; and the operation of a radiation and safety survey program. The Safety Department is responsible for maintaining a high level of staff safety in all of ORNL's activities. This program includes aspects of both operational and industrial safety and also coordinates the activities of the ORNL Director's Safety Review Committees. The Environmental Management Department is responsible for ensuring that the activities of the various organizations within ORNL are carried out in a responsible and safe manner. This responsibility involves the measurement, field monitoring, and evaluation of the amounts of radionuclides and hazardous materials released to the environment and the control of hazardous materials used within ORNL. The department also collaborates in the design of ORNL facilities to help reduce the level of materials released to the environment as a result of ORNL operations.

2. Summary of Technical Highlights

2.1 HEALTH PHYSICS DEPARTMENT

- The maximum whole-body dose sustained by an employee was about 21 mSv (2.1 rem), which is 42% of the applicable standard of 50 mSv (5 rem).
- The greatest cumulative whole-body dose received by an employee was about 1.15 Sv (115 rem). This dose was accrued over an employment period of about 39 years and represents an average of about 29 mSv/year (2.9 rem/year).
- The greatest cumulative dose to the skin of the whole body received by an employee during 1982 was about 65 mSv (6.5 rem), or 43% of the applicable standard of 150 mSv (15 rem).
- The maximum cumulative hand dose recorded during the year was about 65 mSv (6.5 rem), or 9% of the applicable standard of 750 mSv (75 rem).
- During the year, no cases of internal exposure occurred for which the amount of radioactive material within the body averaged as much as one-half the maximum permissible organ burden for the year.
- A study of the differential translocation of $^{238}PuO_2$ and $^{239}PuO_2$ was carried out in a lung-simulant system to determine the relative biological transport.
- Small quantities of various fission or activation products were identified in a few individuals, but no one was found to have an internal deposition greater than 10% of the maximum permissible organ burden of that isotope for the year.
- A study was completed on detection of the levels of ^{210}Pb in the lungs of smokers.
- A B-mode ultrasound unit for measuring chest wall thickness and percent thoracic fat was acquired to provide calibration correction for in vivo detection of transuranics.
- The clearance of ^{202}Tl contaminant following intravenous injection of ^{201}Tl was studied to develop clearance functions for dose estimation purposes.
- A study was made of population dose estimates associated with a hypothetical release of noble gases and ^{131}I from the Three Mile Island Nuclear Station, Unit 1.
- Experimentation was completed on a $CaF_2(Eu)$-NaI(Tl) phoswich detector to be used for alpha-beta-gamma spectroscopy of environmental samples.
- A study was performed on total-body content of ^{40}K and percent body fat estimation for use in in vivo detection of the actinides.

- An inspection and radiation survey was performed on each of 80 x-ray units located at ORNL to ensure that the units were in compliance with all applicable regulations, American National Standard N43.2, and ORNL Health Physics Procedure 2.8.

- A study identifying all radio-frequency-generating devices at ORNL was completed, and a new procedure, which will parallel the new American National Standards Institute (ANSI) Standard C95.1 for radio-frequency-generating devices, was drafted.

- Work on the upgrading of the Laboratory cell ventilation and off-gas system continued consistent with optimum radiation protection procedures.

- Drain lines, partially filled with uranium and thorium, were removed in Building 9204-1.

- A preliminary survey of the cell ventilation duct from Building 3517 to the stack at Building 3039 was performed, and exposure of the participating personnel was held to <0.1 mSv (<10 mrem).

2.2 DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

- Atmospheric iodine sampled at the perimeter stations averaged less than 0.37E−04 Bq/m^3 (0.10E−14 μCi/cc) during 1982. This average represents 0.001% of the concentration guide of 3.7 Bq/m^3 (1E−10 μCi/cc) applicable to inhalation of ^{131}I released to uncontrolled areas. The maximum concentration observed for one week was 0.48E−4 Bq/m^3 (0.13E−14 μCi/cc).

- All air samples taken had values below the allowable standards.

- The concentrations of ^{131}I in milk collected near ORNL and from all remotely located stations are within Federal Radiation Council (FRC) range I. All results were below the minimum detectable concentration for ^{131}I in milk [17 mBq/L (0.45 pCi/L)].

- The concentrations of ^{90}Sr in milk both from the immediate and remote environs of ORNL are also within FRC range I.

- The average value of 0.41E−1 Bq/L (1.1E−9 μCi/mL) ^{90}Sr in potable water represents 0.4% of the CG_w for drinking water applicable to individuals in the general population.

- A maximum potential whole-body dose of 1.8 mSv/year (180 mrem/year) was calculated for the maximum potential fence-post dose, assuming that an individual remained at this point for 24 h/d for the entire year. The calculated maximum potential exposure is 36% of the allowable standard.

- The ORNL meteorological tower system became operational.

- During 1982, about 450 disposal requests were handled by the Hazardous Materials Control and Disposal group.

- About 11,000 L of silver-bearing wastes were processed.

2.3 SAFETY DEPARTMENT

- No facility or nuclear reactor accidents or incidents of an operational nature occurred during 1982 that resulted in injury to personnel or that were reportable to the U.S. Department of Energy (DOE) other than as unusual occurrences or quality-deficiency reports.

- Effective August 1, 1982, the Safety Department assumed responsibility for ORNL's Unusual Occurrence Reporting (UOR) Program as designated ORNL coordinator of the program for production and distribution of all Laboratory-generated UORs.
- Staff members participated in 64 meetings of the Laboratory Director's Review Committees.
- Implementation of DOE and DOE-ORO Orders 5481.1A, "Safety Analysis and Review System" continued.
- Effective health physics and operational safety coordination of decontamination and decommissioning work was provided.
- Through June 16, 1982, the Laboratory accumulated 767 days (17,907,911 exposure-hours) without a lost-work-day case. This set a Union Carbide Corporation-Nuclear Division (UCC-ND) and UCC installation record.
- The Laboratory earned the following awards for safety performance in 1982:
    - UCC Gold Award for Outstanding Safety Performance for operating 16,000,000 employee-hours without a lost-work-day case from May 11, 1980, through June 16, 1982.
    - National Safety Council (NSC) Award of Honor for the eighth consecutive year (NSC's highest award).
    - DOE Award of Excellence for maintaining the incidence rate of lost work days and restricted work cases below 1.1 for five years.
- A new color videotape describing the overall ORNL safety program was developed for use by ORNL staff.

3. Health Physics Department

H. W. Dickson

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B. D. Gonzalez	D. G. Noe	

3.1 RADIATION MONITORING

3.1.1 Personnel Monitoring

All persons who enter Laboratory areas where they are likely to be exposed to radiation or radioactive materials are monitored for the probable kinds of exposure. External radiation dosimetry is accomplished mainly by means of badge meters, pocket ion chambers, and hand exposure meters. Internal deposition is determined from bioassays and in vivo counting.

Dose Analysis Summary

External exposures. In 1982, no employee received a whole-body radiation dose that exceeded the standards for radiation protection given in DOE Order 5480.1.[1] The maximum whole-body dose

1. DOE Order 5480.1, Chap. XI.

sustained by an employee was about 21 mSv (2.1 rem), or 42% of the applicable standard of 50 mSv (5 rem). The range of doses to persons using ORNL badge meters is shown in Table 3.1.

At the end of 1982, no employee had a cumulative whole-body dose greater than the applicable standard based on the age proration formula $5(N - 18)$ (Table 3.2). No employee had an average annual dose that exceeds 50 mSv/year (5 rem/year) of employment (Table 3.3). The greatest cumulative whole-body dose received by an employee was about 1.15 Sv (115 rem). This dose was accrued over an employment period of about 39 years and represents an average of about 29 mSv/year (2.9 rem/year).

The greatest cumulative dose to the skin of the whole body received by an employee during 1982 was about 65 mSv (6.5 rem), or 43% of the applicable standard of 150 mSv (15 rem). The maximum cumulative hand dose recorded during the year was about 65 mSv (6.5 rem), or 9% of the applicable standard of 750 mSv (75 rem). The average of the ten greatest whole-body doses to ORNL employees for each of the years 1978 through 1982 is shown in Table 3.4.

Table 3.1. 1982 dose data summary for monitored personnel involving exposure to whole-body radiation

Group	Dose range [mSv (rem)]							Total
	0–1 (0–0.1)	1–10 (0.1–1)	10–20 (1–2)	20–30 (2–3)	30–40 (3–4)	40–50 (4–5)	50 up (5 up)	
ORNL employees	63	261	28	1	0	0	0	353
ORNL-monitored nonemployees	601	21	2	0	0	0	0	624
Total	664	282	30	1	0	0	0	977

Table 3.2. 1982 average dose per year since age 18

Group	Dose range [mSv (rem)]						Total
	0–10 (0–1)	10–20 (1–2)	20–30 (2–3)	30–40 (3–4)	40–50 (4–5)	50 up (5 up)	
ORNL employees	321	27	5	0	0	0	353

Table 3.3. 1982 average dose per year of employment at ORNL

Group	Dose range [mSv (rem)]						Total
	0–10 (0–1)	10–20 (1–2)	20–30 (2–3)	30–40 (3–4)	40–50 (4–5)	50 up (5 up)	
ORNL employees	281	66	6	0	0	0	353

Table 3.4. Average of ten highest whole-body doses and highest individual dose by year

Year	Ten highest doses (average)		Highest dose	
	mSv	rem	mSv	rem
1978	23.9	2.39	33.4	3.34
1979	22.4	2.24	28.0	2.80
1980	24.6	2.46	31.4	3.14
1981	22.0	2.20	38.3	3.83
1982	16.1	1.61	21.1	2.11

Internal exposures. During the year no cases of internal exposure occurred for which the amount of radioactive material within the body averaged as much as one-half the maximum permissible organ burden for the year.

External Dose Techniques

Thermoluminescent dosimeters. Standard thermoluminescent dosimeters (TLDs) are issued to all employees and to photobadged nonemployees who work in radiation zones. Standard TLD meters have two TLD chips—one shielded and one unshielded. Specialized meters with various complements of TLDs and films are issued to those who may be exposed to radiations other than gamma and energetic beta.

TLD meters of radiation workers are exchanged and processed quarterly, or more frequently if required for exposure control. All other meters are exchanged and processed annually.

External dosimetry data. A computer-prepared report that includes data of recorded skin dose and whole-body dose for the previous calendar quarter and totals for the current year is published quarterly. ORNL divisions receive a computer-prepared report that is an annual summary of the quarterly reports.

Pocket meters. Pocket meters (indirect reading, ionization chambers) are made available at all principal points of entry to ORNL. A pair of pocket meters is carried for the duration of a work shift by persons who work in an area where the potential exists for a dose of 0.2 mGy (20 mrad) or more during the work shift. Pocket meter pairs are processed each day by health physics technicians. Readings of 0.2 mGy (20 mrad) or more are reported to supervision daily. Over 140,000 pocket ionization chambers were used and processed during 1982. Printouts giving all readings, along with weekly totals and cumulative totals, are sent to supervision weekly. Pocket meter readings are used for estimating integrated exposure and as a basis for TLD meter processing during a TLD meter assignment period.

Pocket meter data. A report, which includes the names, ORNL divisions, and readings for pocket meters that were 0.2 mGy (20 mrad) or greater during the previous 24 h, is prepared and distributed daily to ORNL supervision

A computer-prepared report that includes all pocket meter data for the previous week and summary data for the calendar quarter is published and distributed weekly.

Hand exposure meters. Hand exposure meters are TLD-loaded finger rings. Hand exposure meters are issued to persons for use during operations in which the hand dose is likely to exceed 10 mSv (1 rem) during the week. They are issued and collected by Radiation and Safety Surveys (R&SS) Section personnel, who determine the need for this type of monitoring and arrange for a processing schedule. A summary of personnel meters services is presented in Table 3.5.

Internal Dose Techniques

Bioassay. Urine and fecal samples are analyzed to determine the amounts of internal intake. The frequency of sampling and the type of radiochemical analysis performed are based on each specific radioisotope and the intake potential.

In most cases, bioassay data require interpretation to determine the dose to the person; computer programs are used to evaluate extensive data on urinary excretion of ^{239}Pu. An estimate of dose is made for all cases in which one-fourth of a maximum permissible organ burden averaged over a calendar year may be exceeded. The analyses performed by the Industrial Safety and Applied Health Physics (IS&AHP) radiochemical laboratory during 1982 are summarized in Table 3.6.

Table 3.5. Personnel meters devices

	1980	1981	1982
Pocket meter usage			
Number of pairs used			
ORNL	69,410	69,722	64,418
CPAF[a]	5,026	6,384	6,210
Total	74,436	76,106	70,628
Average number of users per quarter			
ORNL	671	673	623
CPAF[a]	109	133	135
Total	780	806	758
Meters processed for monitoring data			
Beta-gamma badge-meter	15,260	3,548	3,590
Neutron badge-meter	1,030	1,159	1,177
Hand meter	460	285	296

[a]Cost plus award-fee contractor (Rust Engineering).

Table 3.6. Radiochemical laboratory analyses, 1982

Radionuclide	Urine	Feces	Milk	Water	Controls
Plutonium, α	440	2		52	90
Transplutonium, α	357	2		52	90
Uranium, α	141				60
Strontium, β	145		400		40
Tritium	132			104	52
^{131}I			400		10
Other	24				20
Total	1239	4	800	208	362

Bioassay data. A computer-prepared report that includes data of sample status and results for the previous week is published and distributed weekly, and quarterly and annual reports of results are also prepared and distributed.

Whole-body counter. The whole-body counter (an in vivo gamma spectrometer) is used for estimating internally deposited quantities of most radionuclides that emit photons or X rays.

About 650 whole-body, chest, wound, thyroid, and liver counts were performed at the Whole Body Counter Facility during the year. Most of the subjects counted had ^{137}Cs in the range of 185–1221 Bq (5–33 nCi) from fallout from nuclear weapons testing. Small quantities of various fission or activation products were identified in a few individuals, and there were two cases of actinide intake. However, no one was found to have an internal deposition greater than 10% of the maximum permissible organ burden of that isotope for the year.

Whole-body counter data. Preliminary results of an analysis are reported on a card form soon after counting is completed. A computer-prepared report is published and distributed quarterly and annually.

Counting facility. The counting facility determines the radioactivity content of air-filter, water, and various other samples submitted by the IS&AHP sections. A summary of the analyses is given in Table 3.7.

3.1.2 Health Physics Instrumentation

The IS&AHP Division shares with the Instrumentation and Controls (I&C) Division the responsibility of selecting electronic radiation monitoring instruments used in the ORNL health physics program. Normally, the IS&AHP Division is responsible for determining the need for new instrument types and modifications to existing types, for specifying the health physics design requirements, and for approving the design. The IS&AHP Division is also responsible for calibrating all instruments used in the health physics program and is allocated the funds for maintenance of these instruments. Maintenance is performed or cross-ordered by the I&C Division.

Nonelectronic personnel monitoring devices are designed, tested, calibrated, and maintained by IS&AHP Division personnel.

Table 3.7. Counting facility analyses, 1982

Type of sample	Number of samples		Total
	α	β	
Facility monitoring			
Smears	20,898	20,769	41,667
Air filters	14,405	13,916	28,321
Environs monitoring			
Air filters	3,179	3,179	6,358
Fallout		2,986	2,986
Rainwater		753	753
Surface water		297	297

Instrument Inventory

The electronic instruments used in the health physics program are divided, for convenience of servicing and calibrating, into two classes: battery-powered, portable instruments and ac-powered stationary instruments. The portable instruments are assigned and issued to the R&SS complexes. The stationary instruments are the property of the ORNL division responsible for monitoring the areas in which the instruments are located. Table 3.8 lists the portable instruments assigned at the end of 1982, and Table 3.9 lists the stationary instruments in use at the end of 1982.

Inventory and service summaries for health physics instruments are prepared by computer. These computer-programmed reports enable the Instruments Group to maintain a current inventory on most health physics instrument requirements. The allocation of stationary health physics monitoring instruments by division is shown in Table 3.10.

Calibration Facility

The IS&AHP Division maintains a facility for the calibration and maintenance of portable radiation instruments and personnel metering devices. The facility is equipped with calibration sources, remote-control devices, and shop space for the use of I&C Division maintenance personnel. The IS&AHP personnel assign, calibrate, arrange for maintenance of, provide for delivery of, and maintain inventory and servicing data on all portable health physics instruments.

Table 3.8. Portable instrument inventory

Instrument type	Number		Total (Jan. 1, 1983)
	Installed	Retired	
GM survey meter	3	2	318
Cutie pie	30	18	316
Alpha survey meter	6	1	259
Neutron survey meter	0	0	101
Miscellaneous	0	0	6
Total	39	22	1002

Table 3.9. Inventory of facility radiation monitoring instruments, 1982

Instrument type	Number		Total (Jan. 1, 1983)
	Installed	Retired	
Air monitor, α	2	0	112
Air monitor, β	1	7	154
Lab monitor, α	0	4	180
Lab monitor, β	2	0	231
Monitor	0	1	203
Other	1	5	140
Total	6	17	1020

Table 3.10. Divisional allocation of health physics facility monitoring instruments, 1982

ORNL division	α air monitor	β air monitor	α lab monitor	β lab monitor	Monitron	Other	Total
Analytical Chemistry	8	11	15	20	12	3	69
Chemical Technology	44	29	64	47	44	29	257
Chemistry	7	1	13	14	0	2	37
Metals and Ceramics	15	15	22	12	8	17	89
Operations	24	85	50	91	111	50	411
Physics	2	2	4	15	3	3	29
Others	12	11	12	31	25	35	126
Total	112	154	180	230	203	139	1018

Radiation sources used for calibration have been either standardized by the National Bureau of Standards (NBS) or evaluated by comparison with sources standardized by the bureau.

The recommended maintenance and calibration frequency is two (no more than three) months for instruments that measure exposure, absorbed dose, or dose equivalent rates (cutie pie, Juno, and fast-neutron survey meter) and three (no more than four) months for count-rate instruments [gas flow, scintillation, Geiger-Mueller survey meter (GMSM), thermal neutron, and air proportional]. Table 3.11 shows the number of calibrations of portable instruments and personnel monitoring devices for 1982.

Table 3.11. Calibrations facility resume, 1982

Item	Number of calibrations
Beta-gamma survey meters	2141
Neutron survey meters	311
Alpha survey meters	768
Personal dosimeters	3320
Badge dosimetry components	1640

3.1.3 Developments

The Impact of an Isotopic Effect on the Interpretation of Bioassay Data for Plutonium

This reasearch was undertaken to determine if $^{238}PuO_2$, because of its higher specific activity with attendant aggregate recoil, undergoes a higher transfer through a membrane filter into an interstitial human alveolar lung fluid simulant than does $^{239}PuO_2$. The transfer rate was determined in an **in vitro** chamber designed to simulate the characteristics of the human alveolar interstitium. The ratio of the transfer rate for ^{238}Pu:^{239}Pu was 138 $\pm$ 76%. This result is significant and indicates that the recoil transfer of ^{238}Pu from the alveolar interstitium through the capillary endothelial membrane into blood may be expected to be at a higher rate for inhaled $^{238}PuO_2$ than for $^{239}PuO_2$.

Detection of ^{210}Pb in the Lungs of Smokers

Because mainstream smoke is highly enriched in ^{210}Pb, alpha radiation from inhaled cigarette smoke particles has been proposed as a cancer-producing agent in cigarette smokers. Both ^{210}Po and ^{210}Pb have been observed in tobacco, cigarette smoke, and the lungs of smokers. Because ^{210}Pb is highly enriched in mainstream smoke, there have been estimates of yearly excesses of ^{210}Pb in the lungs of "one-pack-a-day" smokers of 0.11–0.37 Bq (3–10 pCi). The ORNL Whole Body Counter Facility was used to verify this estimate by the methodology of high-resolution in vivo gamma spectrometry.

Measurements were made on 113 adult male radiation workers who have either smoked at least one pack of cigarettes per day for at least five years or who have never smoked cigarettes. An analysis-of-variance table was generated based on the lead ratio for each individual. The results revealed that there was no statistically significant increase in the amount of ^{210}Pb in the lungs of smokers over those of nonsmokers.

Imaging Ultrasound as a Tool for Measuring Chest-Wall Thickness and Percent Thoracic Fat in Whole-Body Count Subjects

A B-mode ultrasound unit has been instituted recently at the ORNL Whole Body Counter Facility as a means of measuring chest-wall thickness and percent thoracic fat in order to provide calibration correction for in vivo detection of transuranics and other low-energy photon emitters. Because of the system design and superior resolution down to a depth of about 5 cm of tissue, individual measurements are accurate to within $\pm 1\%$. The institution of this technique has reduced our error in estimation of the quantity of internally deposited low-energy photon and x-ray emitters significantly because every millimeter error made in estimating the thickness of the chest wall results in at least a 20% error in the final assessment of lung burden for many of the transuranics.

Future plans include institution of a direct ultrasound/computer interface to improve the accuracy of estimation of total chest-wall thickness and percent thoracic fat. Because of the superior resolution of this system, it is felt that it could be useful in localizing radioactive or inert particles in shallow wounds for the purpose of debridement. This area of research has yet to be investigated.

Clearance of ^{202}Tl Contaminate Following Intravenous Injection of ^{201}Tl

Because little is known about the metabolism of thallium, the clearance of ^{202}Tl (half-life = 12 d) was determined by in vivo gamma spectrometry for a 50-year-old male who underwent a medical administration of ^{201}Tl (half-life = 73 h) for cardiac perfusion study. Analysis of data, which were acquired beginning 12 d after injection, resulted in a two-part clearance function best described by an exponential equation from day 1 of measurement to day 36, and a power function for day 36 to day 50. This function, which has been derived from data from a single individual, could be useful in the planning of internal exposure. But, because variables such as source distribution, organ size, and excretion rates from person to person, the function is not intended for use as a dosimetric model.

Population Dose Estimation from a Hypothetical Release of Noble Gases and of ^{131}I at the Three Mile Island Nuclear Station, Unit 2

A Gaussian plume computer code (AIRDOS-EPA)[2] was used to estimate the collective dose to the population within 80 km (50 miles) of the Three Mile Island Nuclear Station, Unit 2 from a

2. R. E. Moore et al., *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides,* EPA 520/1-79-009, Washington, D.C., 1979.

hypothetical release of 89 PBq (2.4 × 10^6 Ci) of noble gases and about 370 TBq (1 × 10^4 Ci) of ^{131}I. When ^{131}I is treated as a particle in its dispersion, the estimated collective total-body dose is about 29.8 person-Sv (2980 person-rem) of which 54% results from ^{131}I; when treated as a vapor, the collective dose is about 21.4 person-Sv (2140 person-rem) of which 40% results from ^{131}I. Comparison of calculated activity of ^{131}I per liter of milk (from maximum individual dose in isolated sector grids) with measured values of activity of ^{131}I per liter yields agreement within a factor of from 1.5 to 15, when ^{131}I is treated as a particulate, thus leading the authors to believe that dispersion of a particulate more closely approximates the incident as it occurred in March 1979 and that AIRDOS-EPA is an adequate dispersion model for this study. Collective total-body dose per 3.7 × 10^{10} Bq (1 Ci) of ^{131}I released is calculated to be 0.0016 person-Sv (0.16 person-rem). When meteorological conditions are changed from those that occurred during the incident (wind speed reduced to 1 m/s and stable atmospheric conditions), the collective dose decreases because of the rapid fallout of ^{131}I in low population zones close to the plant. The population dose from the scenario presented in this report is too small for any significant health effects to be realized.

Total-Body Content of ^{40}K and Percent Body Fat Estimation for Use in In Vivo Detection of the Actinides

Assessment of lung burden of the actinides in humans requires knowledge of ^{40}K content (for Compton-scatter correction) and percent body fat (for attenuation correction for 17- to 21-keV internal conversion L X rays). Total-body content of potassium is known to change with age. Similarly, a correlation between total-body content of ^{40}K and lean-body mass for a small age range has been demonstrated. But how these parameters as well as others, such as chest-wall thickness, height, and percent body fat, are interrelated has not been concluded. For this investigation, a broad range of male subjects was studied to determine relationships between the body content of ^{40}K and various biometric measurements in order to provide correction factors for lung counting.

Correlation coefficients for ^{40}K content and various biometric measurements were obtained from studies of 61 subjects. All were adult males with no evidence of internal deposition of other than naturally occurring radionuclides. Ranges for height, weight, and age were as follows: height, 165–190 cm; weight, 59–117.5 kg; age, 27–63 years.

Calibration of a Large, Hyperpure Germanium Detector Array for Actinide Lung Counting with a Tissue-Equivalent Torso Phantom

A tissue-equivalent torso phantom, which is on loan from Lawrence Livermore National Laboratory, was used to derive calibration curves (chest-wall thickness vs nanocuries per counts per minute) for a large, hyperpure germanium detector array for measurement of lung burdens of ^{238}Pu, ^{239}Pu, and ^{241}Am. Equations were derived using a 100% muscle thorax as well as correction factors for varying the concentrations of thoracic fat. Because of the superior energy resolution of the array, a means for estimating chest-wall thickness was also determined. These results have been compiled, and existing computer programs for data analysis have been adapted accordingly as part of the routine actinide lung-counting program at ORNL. Although semiconductor detectors, in general, have been shown to be well suited to in vivo actinide detection, design problems associated with this detector array were noted as part of this study, which will play a large part in long-range plans for the continued development of the ORNL Whole Body Counter Facility.

Calcium Fluoride-Sodium Iodide Phoswich for Sample Analysis

Experimentation was completed on a CaF_2(Eu)-NaI(Tl) phoswich detector for alpha-beta-gamma spectroscopy of environmental samples. It was found to permit rapid assessment of particulate and photon-emitter contamination in soils at sufficiently low concentrations (i.e., <1.18 Bq $^{239}Pu/g$ (<30.0 pCi $^{239}Pu/g$) of soil at the 2-σ count level) to direct initial field decommissioning and decontamination operations. Of particular importance is its applicability during initial surveys when characterization of alpha and beta contamination in the presence of a high gamma background is necessary. Work is progressing in putting together a complete spectroscopy system for in situ use.

3.2 RADIATION AND SAFETY SURVEYS

3.2.1 Laboratory Operations Monitoring

The R&SS section provided radiation and safety surveillance services to the research and operating groups in support of efforts to keep exposures to personnel, concentrations of airborne radioactivity, and levels of surface contamination well within permissible limits and in agreement with the as-low-as-reasonably-achievable (ALARA) philosophy. Assistance in coping with the problems associated with radiation work, other than surveillance, was provided through seminars, safety meetings, and discussions with those planning, supervising, and performing the work. The vast majority of our ORNL operations proceed without incident; however, during 1982, there were 12 minor incidents, one of which resulted in an extensive investigation even though the exposures involved were below the level requiring an official report. The following is a brief review of some of the major nonroutine activities involving R&SS staff.

Analytical Chemistry Operations, Buildings 2026 and 3019

The Analytical Chemistry Division performs a variety of analyses on radioactive samples from customers throughout ORNL and from some off-site customers. Several laboratories in Building 3019 and laboratories and cells in Building 2026 provide containment and shielding for these operations. In addition to surveillance of routine operations in these facilities, health physics personnel participated in the planning of and provided close monitoring for a number of jobs with unusual hazard potential. These included replacement of grossly contaminated High Radiation Level Analytical Facility (HRLAF) prefilters and frames, replacement of two highly contaminated glove boxes, replacement of charcoal with radioiodine filters in Building 2026, and the transferring and packaging of highly radioactive waste from Building 2026 cells. The Analytical Chemistry Division management and operating personnel were very cooperative in conducting operations in accordance with the ALARA concept.

Bulk Shielding Reactor (BSR), Building 3010

In 1982, the BSR was used primarily for short-term irradiation of various samples submitted by several research divisions at ORNL. One division in particular, the Analytical Chemistry Division, irradiated about 1000 samples while conducting a multielement soil analysis program for the U.S. Geological Survey. These samples were removed from the core and transferred to the gamma spectroscopy laboratory in Building 3042. Health Physics surveillance indicated a minimum of radiation exposure to personnel involved in these operations.

Radiochemical Pilot Plant Operations, Building 3019

Radiochemical Pilot Plant Operations included (1) installation of the new dissolver and extraction column in cell 5; (2) maintenance, testing, and operations of the dissolver, solvent extraction system, and ion exchange system; (3) fissile material storage and transfers; (4) Consolidated Edison Uranium Solidification Program (CEUSP) development work and equipment mock-up and testing and some equipment installation in cell 3; (5) and installation and cold testing of plutonium-uranium microsphere preparation (PUMP) equipment in Room 209. Health physics consultation, surveillance, and monitoring support were provided for all these and related operations. Radiation Work Permits were certified for 143 jobs having a higher radiation-contamination potential. Radiation and contamination exposure controls were entirely adequate and generally were ALARA.

Isotope Area Operations, Building 3038

Work at this location consisted of the production, packaging, and shipping of radioisotopes for medical, industrial, and experimental uses. Principal isotopes were ^{3}H, ^{60}Co, ^{67}Ga, ^{75}Se, ^{85}Kr, ^{90}Sr, ^{90}Y, ^{153}Gd, ^{137}Cs, ^{192}Ir, ^{237}Np, ^{241}Am, ^{244}Cm, ^{252}Cf, and several isotopes of plutonium. A total of 2067 radioactive shipments were made during the year. The Isotope Research Materials Laboratory continued the fabrication of flux foils from various isotopes of Np, Pu, Th, and U. The laboratory personnel also prepare 20-cm and 50-cm diam ^{3}H targets for shipment to Lawrence Livermore National Laboratory and Japan; the monitoring of all shipments ensured that they were in compliance with applicable U.S. Department of Transportation regulations.

Decontamination of curium cells in Building 3028 and cell D in Building 3047 continued. Readings inside the curium cells varied up to a maximum of 2.5 mGy/h (250 mrad/h), but high transferable contamination continued to be the main problem, with smears counting $>1.0 \times 10^{6}$ α dpm not unusual. Because contamination problems were encountered with personnel, undressing techniques were changed after new procedures were written; the problems were greatly lessened but not completely eliminated.

Readings in cell D ranged from 20 mGy/h (2 rad/h) at the cell door to >1 Gy/h (>100 rad/h) inside the cell. Several ^{192}Ir pellets were found inside the cell; and as these were removed and decontamination of the cell continued, the radiation levels were low enough so that maintenance work in the cell was completed.

Although the alpha contamination levels in the curium cells and the beta-gamma reading in cell D were both extremely high, close monitoring by health physics personnel succeeded in keeping individual dose equivalents within permissible limits.

Oak Ridge Research Reactor (ORR), Building 3042

There was a continuation of several research programs at the ORR facility during 1982. One program of interest consisted of an irradiation test to screen various candidate materials as to their respective suitability for replacing the fully enriched uranium fuel materials currently used by the world's research reactors with a lower enrichment fuel material without significantly degrading reactor operating characteristics and power levels.

All of the experiments inserted and removed from the ORR core were conducted with minimal radiation exposures to operating personnel. These lower radiation exposures were primarily due to the emphasis placed on the ALARA program at the ORR facility.

Manipulator Repair Shop Operations, Building 3074

Master-slave manipulators from hot cell facilities throughout ORNL are brought to Building 3074 (operated by the Plant and Equipment Division) whenever repairs cannot be effected in situ. Often, the manipulator slaves are grossly contaminated with alpha and/or beta-gamma emitters. These slaves must be decontaminated in specially designed glove boxes and then carefully monitored by health physics personnel to determine whether maintenance operations can be safely performed. Upon completion of repairs, the manipulators and their transport carts are monitored to ensure that contamination levels will not present significant problems during interim storage and/or transport and reinstallation in hot cell facilities. Control of radioactive contamination and personnel exposures in this facility has been very good.

Installation of Electropolisher, Building 3517

An electropolisher has been installed on the second level of Building 3517 for decontamination of tools and equipment. Before this installation could be done, area 32 panel board had to be modified and relocated. The modification and relocation had to be monitored closely for contamination resulting from levels of 1×10^6 dpm from the crane bay adjacent to the panel board. Work was accomplished with little spread of contamination outside of established working C-Zones. Total exposure was <0.005 person-Sv (<0.5 person-rem) resulting from tie-ins in the service tunnel.

Transuranium Research Laboratory (TRL), Building 5505

The IS&AHP staff at the TRL continued to provide protective, technical support to experimental programs involving the investigation of physical and chemical properties of transuranic elements. This support included working directly with researchers in the designing of appropriate containment enclosures and procedures that permit performing work with the least exposure or risk. For example, the IS&AHP staff worked closely with a researcher in designing an operation requiring the dividing, packaging, and exact weighing of 1 g ^{241}Am into 30-mg samples for Mossbauer effect studies of transuranium-doped phosphate compounds. [Calculated exposure rates at 10 cm from 1 g ^{241}Am are 11 mC/kg·h (42 R/h) from L X rays and 1.4 mC/kg·h (5.4 R/h) from γ rays.] These operations, which were performed in a glove box, resulted in less than 9% of a permissible weekly hand exposure to the researchers.

The IS&AHP staff also worked with members of the Physics Division in locating and preparing a place in the TRL to monitor the installation of a 2.8-PBq (75,000-Ci) ^{65}Zn-shielded source for their AXION experiment.

In addition, the staff continued to function as building operators in charge of all aspects of the TRL ventilation and containment system. Also, two members of the staff assigned to this facility functioned as the Chemistry Division's Radiation Control and Division Safety Officer (RCO/DSO) and alternate and participated in the preparation and writing of the Operations Safety Requirements Manual for the TRL. One staff member also functioned as a member of the Laboratory Director's Laser Safety Committee.

Holifield Heavy Ion Research Facility, Building 6000

Methods were developed for periodically testing the radiation safety system at the Holifield Heavy Ion Research Facility. These methods were incorporated into a procedure and checklist and are now used quarterly to verify the safety of the system.

Dosimetry Applications Research Facility, Buildings 7709 and 7710

Surveillance services and technical assistance were provided for a number of research programs. These included a continuing mouse-irradiation study for the Biology Division; continuation of a study for the University of Louisville, Louisville, Kentucky, in which mice are injected with various radioprotective drugs before irradiation; preliminary irradiations upon which to base a study of central nervous system damage; tests of criticality detectors and alarm systems for K-25, ORNL, and Argonne West at Idaho National Engineering Laboratory; calibration irradiations of indium strips for Y-12 and ORNL; and activation of indium criticality detector strips for use in a simulated radiation incident at Y-12. A research student studied the use of blood samples (activation of body sodium) and/or hair samples (activation of phosphorus) as accident dosimeters.

The two dosimetry intercomparison studies involving personnel meters and nuclear accident dosimetry systems were conducted again this year by the Health and Safety Research Division. Both studies involved foreign and U.S. participants. The first two of what is expected to become a continuing series of courses in radiation dosimetry were taught this year. The courses make use of the knowledge and expertise of the DOSAR staff and the nearly 20 years of mixed radiation dosimetry intercomparisons. The courses were made available to persons from both nuclear research and power industries and were well received by all who participated. Members of the IS&AHP Division were invited to attend a practice run of the courses.

High Flux Isotope Reactor (HFIR), Building 7900

A cask used to tranfer relatively large pieces of scrap from the HFIR to the burial ground was upgraded by the addition of lead shielding and new, stronger lifting lugs. This cask was then used to transfer the last of the old beryllium reflector segments and other intensely radioactive scrap. The primary isotope of concern was ^{60}Co. Health physics surveillance and assistance were provided for this operation and others. During this operation and the following ones, dose equivalents were held to a minimum, and contamination was confined to designated areas.

1. Loading and transfer of casks of spent reactor fuel, various isotopes, and irradiated target rods.
2. Cleaning and repair of highly radioactive and contaminated tools used in underwater transfer of sources.
3. Surveillance at beam holes for handling of highly irradiated monochromator crystals, beam collimators, plugs, and experiment samples.
4. Repair of primary heat exchangers under high radiation and contamination conditions.
5. Replacement of intensely radioactive resin from the primary coolant clean-up tanks.
6. Replacement of reactor control plate drive rods and seals in the subpile area. Air-lined plastic suits were worn to prevent contamination of men by reactor water leaking down on them during this operation.
7. Reactor shutdown activities, which included removal of radioactive particles from the primary coolant strainer, inspection and testing of reactor pressure vessel components, and repair of various valves and equipment in the primary coolant system.

Transuranium Processing Plant, Building 7920

Health Physics continued coverage in the TRU facility by assisting the Chemical Technology Division and other divisions in maintaining safe operating techniques. The isotopes produced at TRU continue to be used nationally and internationally to study basic physics and chemistry of transuranium elements, including experiments to produce new superheavy elements. Health Physics personnel provided surveillance and assistance for personnel during radioactive shipments and for the working environs in Building 7920. Maintenance periods involved a hopcolite filter change, a cell pit tank replacement, stack fan repair, and window repairs for cell or cubicle areas. Health Physics coverage of new programs such as the Solvent Extraction Test Facility (SETF) and target fabrication of ^{227}Ac, ^{248}Cm, ^{252}Cf, and ^{254}Es were sufficient to prevent any release of radioactivity.

Laundry Monitoring Operations

About 507,000 articles of wearing apparel and 212,000 articles such as mops, laundry bags, and towels were monitored at the laundry during 1982. About 5% were found to be contaminated. Of 383,265 khaki garments monitored during the year, only 57 were found to be contaminated.

A total of 5889 full-face respirators and 7625 canisters were monitored during the year. Further decontamination was required after the first cleaning cycle for 229 masks and 403 canisters.

Construction of Monitoring Weirs

Frequent surveillance was necessary during excavation work and construction of new monitoring weirs at White Oak Dam, Melton Branch, and White Oak Creek. Control of contamination was adequate.

Removal of Intermediate-Level Waste (ILW) Transfer Line

Continuous coverage was provided during the cutting and removal of a portion of an abandoned ILW line near White Oak Creek. Personnel exposures were very low, and there was no spread of contamination.

Core Drilling in Solid Waste Storage Area No. 5

Frequent monitoring was necessary for the lump-sum contractor while several monitoring wells were drilled. No contamination was detected on personnel or equipment during the work.

Incoming Isotopes and Empty Containers

About 700 incoming isotopes and empty isotope containers were checked at the ORNL receiving dock during the year. Radiation and contamination measurements indicated that none of the shipments exceeded U.S. Interstate Commerce Commission limitations.

Hydrofracturing Facility

Continuous surveillance was provided during four injections which total about 8.4 PBq (227,400 Ci) of activity (predominantly ^{90}Sr and ^{137}Cs). Also, continuous coverage was necessary during preparatory maintenance and cell decontamination work. Contamination control was adequate, and personnel exposures were well within permissible levels.

Tank Farm Operations

Surveillance continued as the Gunite Tank Sludge Removal Project progressed toward completion. Pumping equipment was installed, and transfer of sludge to the Melton Valley storage tanks was begun. Radiation and contamination levels associated with this work were closely monitored. Personnel exposures were maintained well within permissible limits, and the presence of contamination was confined to the operating area.

3.2.2 Off-Site and Special Surveillance Activities

Oak Ridge Associated Universities (ORAU) Off-Site Assessment Assistance

A member of the R&SS section provided assistance to the ORAU off-site assessment unit. Assistance was provided (12 d) in an area survey of the Lake Ontario Ordinance Works, Lewistown, New York.

Servicing of Threshold Detector Units

The Lexan disks, which were used to record tracks in the threshold detector units at the Reactive Metals, Inc. (RMI), plant in Ashtabula, Ohio, were replaced on site by a member of the R&SS staff. Only those disks placed next to the plutonium foils were removed from the units and replaced. The four units on loan to the RMI plant are serviced annually.

Upgrading of the Laboratory Cell Ventilation and Off-Gas System, Building 3039 Area

Close surveillance was provided for the CPAF contractor (Rust Engineering) personnel as work continued on the upgrading of the Laboratory cell ventilation and off-gas system. Gross contamination and high radiation [15 mC/kg·h (60 R/h)] were encountered during the removal of the electrostatic precipitator. Through the cooperation of all persons involved and the use of ALARA techniques, the contamination was contained, and personnel exposures were kept well below maximum permissible levels. By the end of 1982, the precipitator was removed, the temporary fans were in place, and the installation of the temporary bypass air ducts was about 90% complete.

Removing Drain Lines in Building 9204-1

Surveillance was provided while drain lines, partially filled with uranium and thorium, were removed. The drain lines were no longer needed and were reading above background levels on the outside surface. Work was provided by Rust Engineering.

X-Ray Survey Program

Eighty x-ray units are located at ORNL: 44 x-ray diffraction units, 12 small cabinet x-ray systems, 10 walk-in-type total-enclosure units, 6 fluoroscopy units, 3 radiographic units in hot cells, 3 portable radiographic units, 1 particle-size analyzer, and 1 medical x-ray unit.

An inspection and a radiation survey were performed on each of these units during the past year to ensure that they were in compliance with ORNL Health Physics Procedure 2.8. The most common problems involved units that were put back into service and changes in shielding configuration without notification of the Health Physics Department. A new procedure has been drafted and will soon go out for final review which will require that all x-ray units meet state and federal regulations and all applicable ANSI standards. This procedure includes extensive engineering standards that will standardize all safety modifications, and a quarterly maintenance program to check electrical safety features.

Microwave Survey Program

A study has been completed identifying all radio-frequency-generating devices at ORNL. These devices range from very low frequencies (10 kHz) to very high frequencies (26 GHz). At this time, we do not have broadband detection instrumentation to assess possible hazards associated with use of this equipment. A new procedure for radio-frequency-generating devices is in draft form and will parallel the new ANSI Standard C95.1.

Inspection of Cell Ventilation Duct

A preliminary survey of the cell ventilation duct running from Building 3517 to the Building 3039 stack was made during this period. The survey was performed to determine radiation hazards and to allow inspection engineering to assess damage and cost to be encountered in the repair of water leaks entering the duct that have developed during the history of its use. Readings ranged from 0.15 mGy/h (15 mrad/h) to 2.0 mGy/h (200 mrad/h) over the entire length of the duct. Contamination controls were adequate and participating personnel received exposures <0.1 mSv (<10 mrem) for the approximate 1 hour each person spent in the duct.

4. Environmental Management Program

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4.1 DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

The DEM of the IS&AHP Division uses three separate monitoring networks to monitor for airborne radioactivity in eastern Tennessee. The local air-monitoring (LAM) network consists of 23 stations positioned relatively close to ORNL operational activities, the perimeter air-monitoring (PAM) network consists of nine stations located on the perimeter of the DOE-controlled area and provides data for evaluating the impact of all Oak Ridge operations on the immediate environment, and the remote air-monitoring (RAM) network consists of 7 stations located outside the DOE-controlled area at distances of 19 to 121 km (12 to 75 miles) from ORNL (Figs. 4.1–4.4). These monitoring networks provide for the collection of (1) airborne radioactivity by air filtration techniques, (2) radioparticulate fallout material by impingement on gummed paper trays, (3) rainwater for measurement of fallout occurring as rain out, (4) radioiodine using charcoal cartridges, and (5) tritium using silica gel (selected LAMs).

After treatment, low-level radioactive liquid wastes originating from ORNL operations are discharged to White Oak Creek, a small tributary of the Clinch River. The radioactive content of White Oak Creek discharge is determined at White Oak Dam, which is the last control point along the stream prior to the entry of White Oak Creek into the Clinch River. Water samples are also collected in the Clinch River at several locations—beginning at a point above the entry of the wastes into the river and ending at Kingston Water Plant near Kingston, Tennessee, the nearest population center downstream (Fig. 4.5).

Samples of White Oak Creek effluent are collected at White Oak Dam by a continuous proportional sampler and analyzed weekly for gross beta, gross alpha, ^{3}H, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{137}Cs, plutonium, and transplutonium elements. Calculations are made of the concentrations of radioactivity in the Clinch River at the point of entry of White Oak Creek [Clinch River Mile (CRM) 20.8] by using

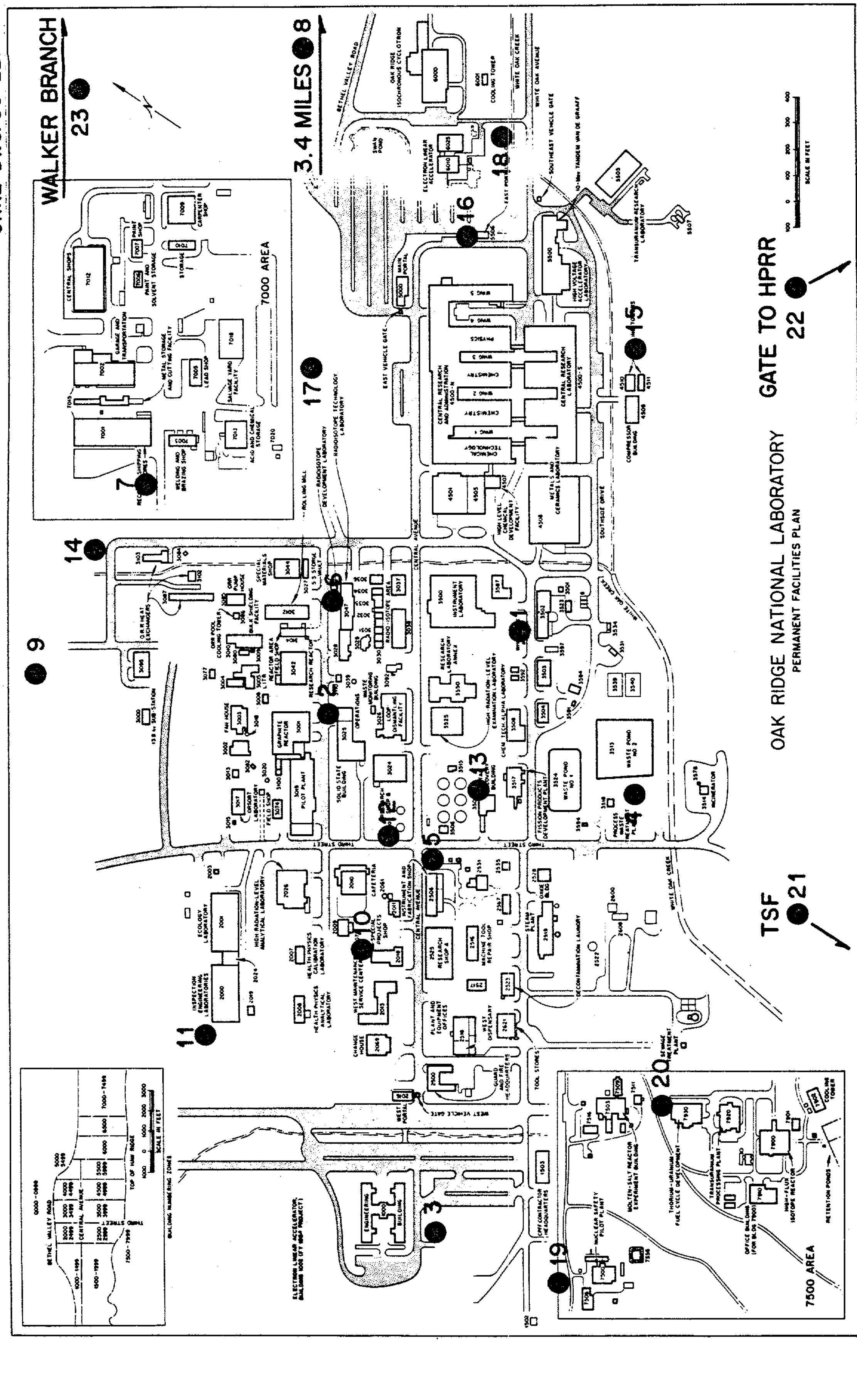

Fig. 4.1. Local air-monitoring (LAM) network—Bethel Valley.

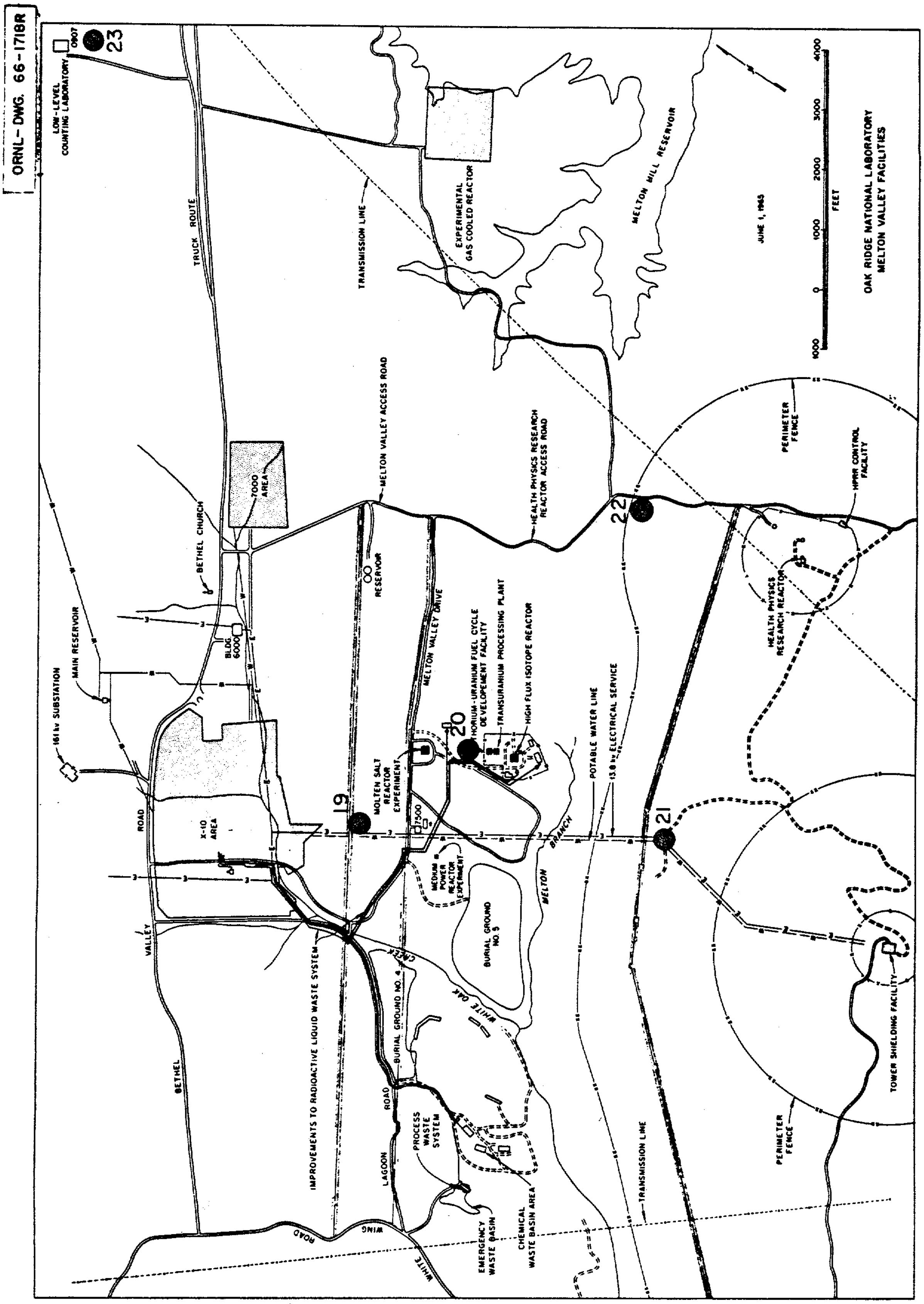

Fig. 4.2. Local air-monitoring (LAM) network—outlying stations.

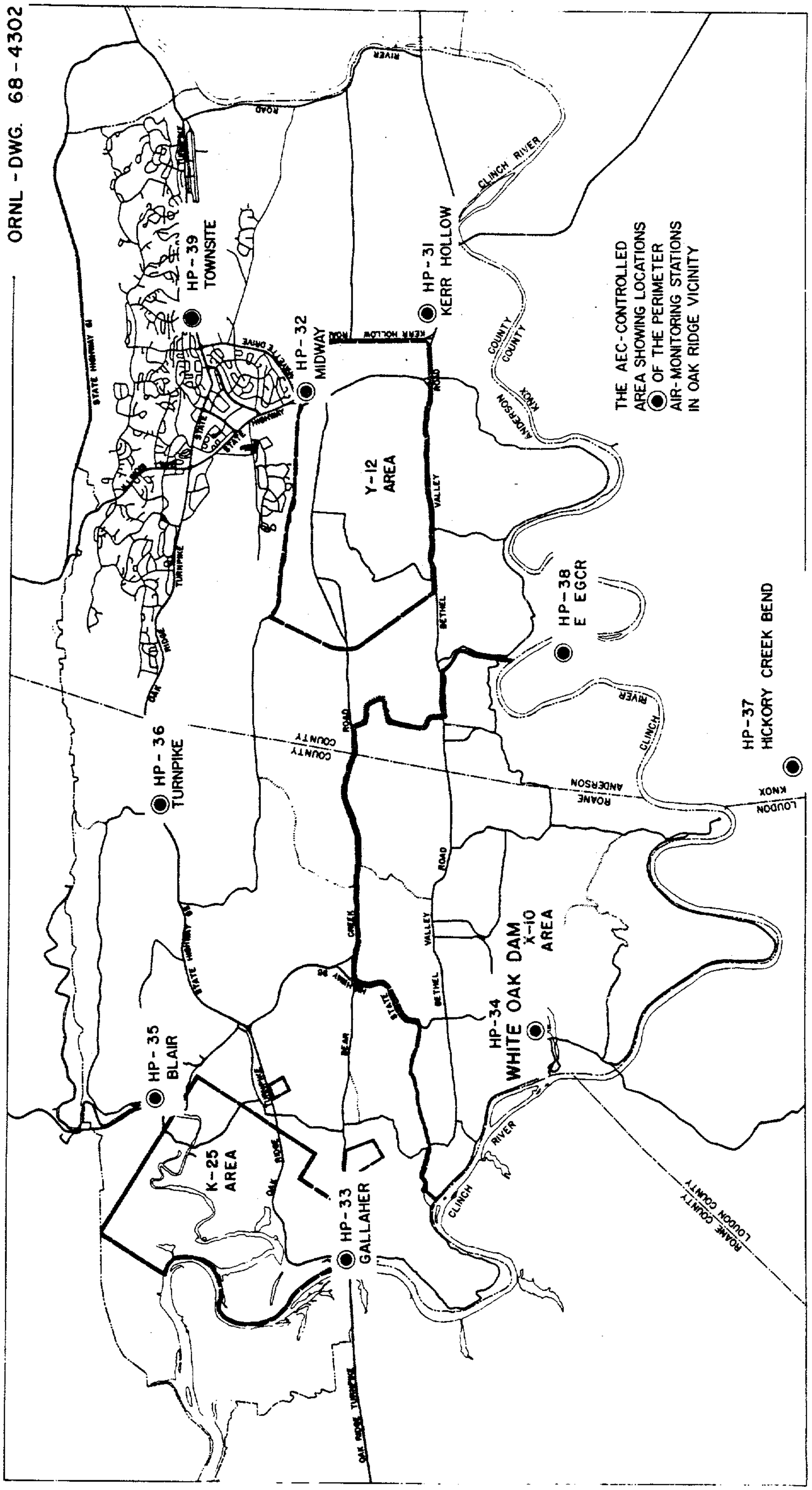

Fig. 4.3. Perimeter air-monitoring (PAM) network.

ORNL-DWG 66-1719R

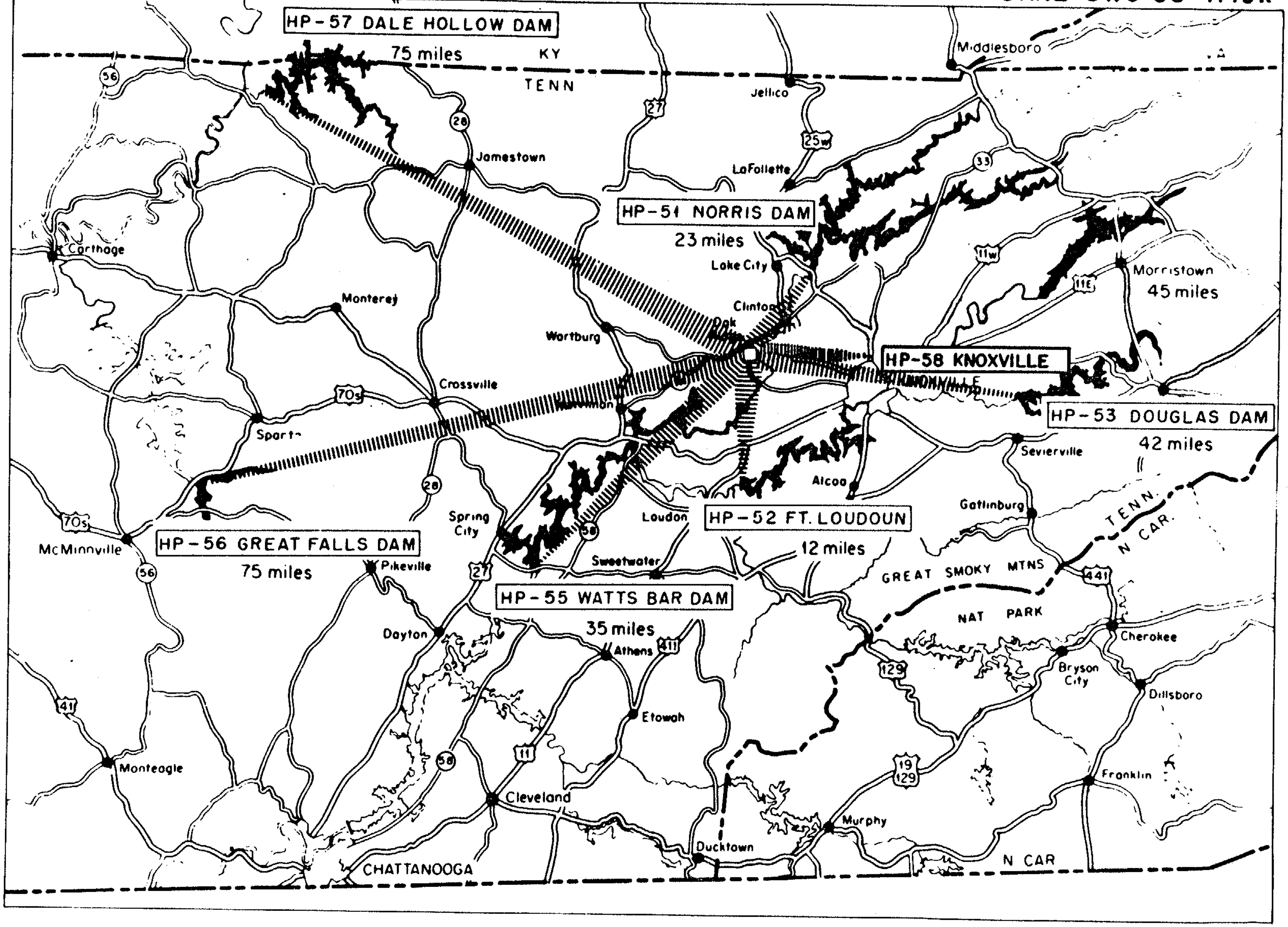

Fig. 4.4. Remote air-monitoring (RAM) network.

ORNL-DWG. 66-2216R2

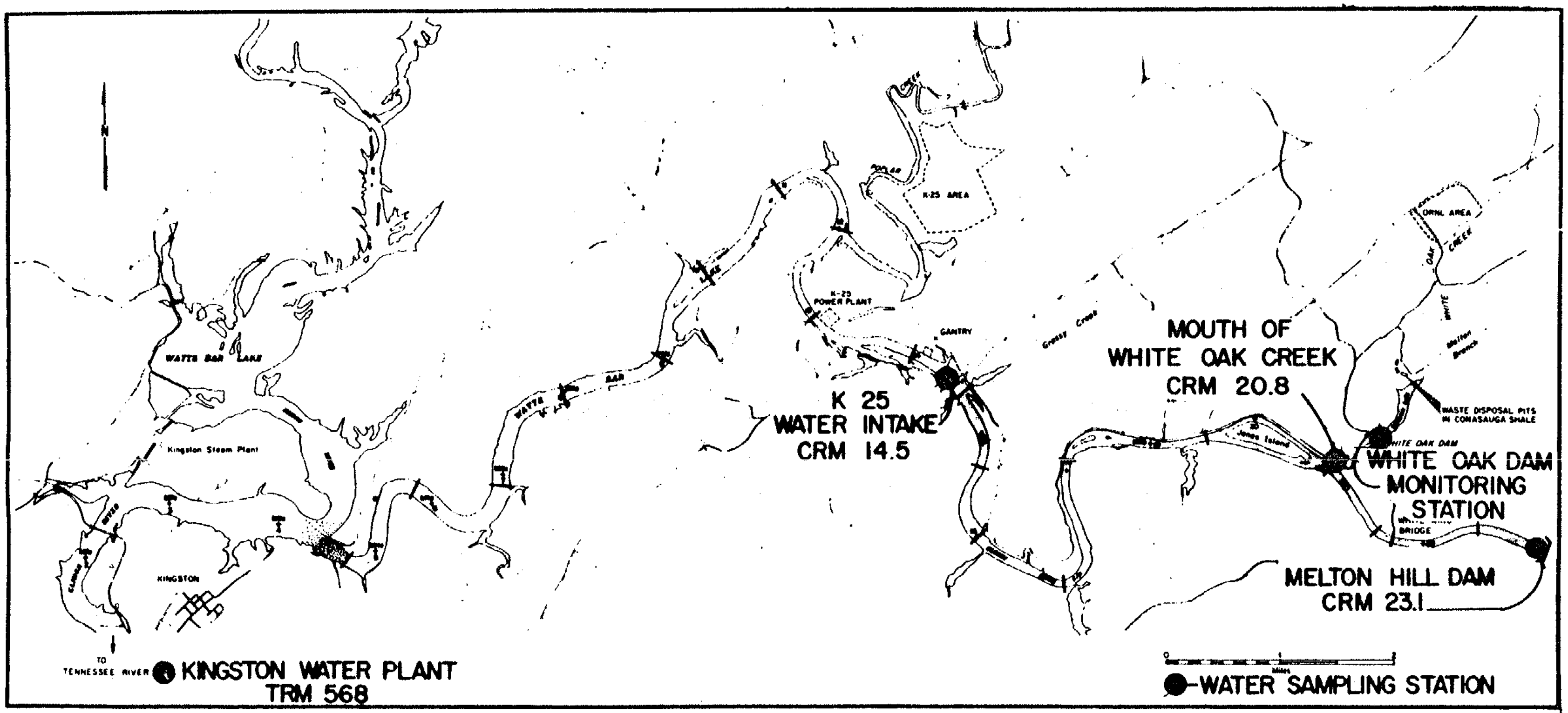

Fig. 4.5. Map showing water-sampling locations in East Tennessee.

the concentrations measured at White Oak Dam and the dilution provided by the river. To verify the calculated concentrations, two sampling stations are maintained in the Clinch River below the point of entry of the wastes—one at the Oak Ridge Gaseous Diffusion Plant (ORGDP) water intake (CRM 14.5) and the other at the Kingston Water Plant near Kingston, Tennessee, at Tennessee River Mile (TRM) 568, which is near CRM 0.0. Another sampling station is maintained in the Clinch River at Melton Hill Dam (CRM 23.1), which is above the point of entry of the waste, to provide baseline data and at the mouth of White Oak Creek (CRM 20.8) to provide backup measurements of the White Oak Dam station.

The ORGDP water-sampling station collects a sample from the Clinch River proportional to the flow in the river near the water intake of the ORGDP water system. The samples are brought into the laboratory at weekly intervals, and an aliquot is composited for quarterly analysis of tritium. The remaining portion of the sample is concentrated by evaporation and is analyzed for gross activity and for individual radionuclides that may be present in significant amounts.

A grab sample of the processed water is collected daily at the Kingston Water Plant sampling station, which is located near the mouth of the Clinch River at TRM 568. The daily grab samples are composited and analyzed quarterly. The preparation of these samples and the analyses performed are the same as those for the ORGDP water-sampling station.

The Melton Hill Dam water-sampling station collects a sample proportional to the flow of water through the power-generating turbines; the sample represents all of the discharge from the dam other than a minor amount discharged in the operation of the locks. Samples are collected from the station weekly and are processed and analyzed in the same manner as those from the ORGDP water-sampling station.

Samples of ORNL's potable water are collected daily and are composited and stored. At the end of each quarter, these composites are analyzed radiochemically for ^{90}Sr content and are assayed for long-lived gamma-emitting radionuclides by gamma spectrometry.

Raw milk is collected at ten sampling stations located within a radius of 80 km (50 miles) from ORNL. Samples are taken weekly from six stations located outside the DOE-controlled area within a 32-km (20-mile) radius of ORNL (Fig. 4.6). Samples are collected every five weeks from the four remaining stations located more remotely with respect to Oak Ridge operations, out to distances of about 80 km (50 miles) (Fig. 4.7). The purpose of the milk-sampling program is twofold: (1) samples collected in the immediate vicinity of ORNL provide data by which the possible effect of effluents from ORNL operations can be evaluated, and (2) samples collected remote to the immediate vicinity of ORNL provide background data essential to establishing a proper index from which releases of radioactive materials originating from the Oak Ridge operations may be evaluated. The milk samples are analyzed by radiochemical techniques for ^{90}Sr and ^{131}I. The minimum detectable concentrations of ^{90}Sr and ^{131}I in milk are 18.5 mBq/L (0.5 pCi/L) and 16.7 mBq/L (0.45 pCi/L), respectively.

External gamma radiation background measurements are made routinely at the LAM, PAM, and RAM stations and at one station located near Melton Hill. Measurements are made using lithium fluoride and calcium fluoride TLDs suspended 1 m above the ground. Dosimeters at the PAM stations and at Melton Hill Dam are collected and analyzed monthly, whereas those at LAM and RAM stations are collected and analyzed semiannually. Dosimeters at the RAM stations are collected annually.

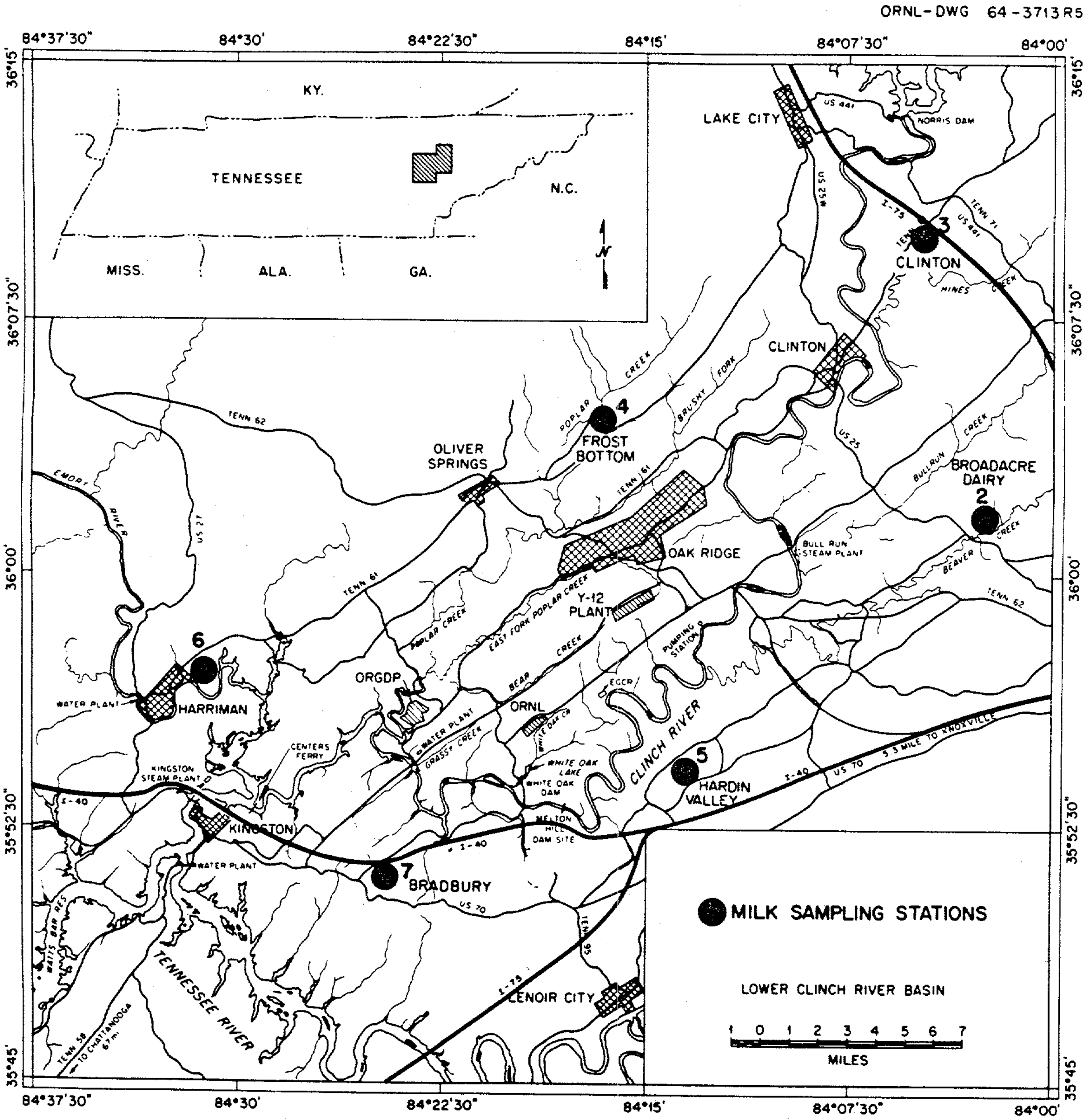

Fig. 4.6. Locations of milk-sampling stations [within 32-km (20-mile) radius of ORNL].

External gamma radiation measurements are also made routinely along the banks of the Clinch River from the mouth of White Oak Creek to points several hundred meters downstream (Fig. 4.8). These measurements were used to evaluate gamma radiation levels resulting from ORNL liquid effluent releases and "sky shine" from an experimental ^{137}Cs plot located near the riverbank. Radiation measurements were made using lithium fluoride TLDS suspended 1 m above the ground surface.

Various species of fish that are commonly caught and eaten in East Tennessee are taken from the Clinch River quarterly from CRM 20.8 (intersection of White Oak Creek and the Clinch River) and annually from other locations in the Clinch River. Ten fish of each species are composited for each sample, and the samples are analyzed by gamma spectrometric and radiochemical techniques for the critical radionuclides that may contribute significantly to the potential radiation dose to man.

ORNL–DWG 83-10730

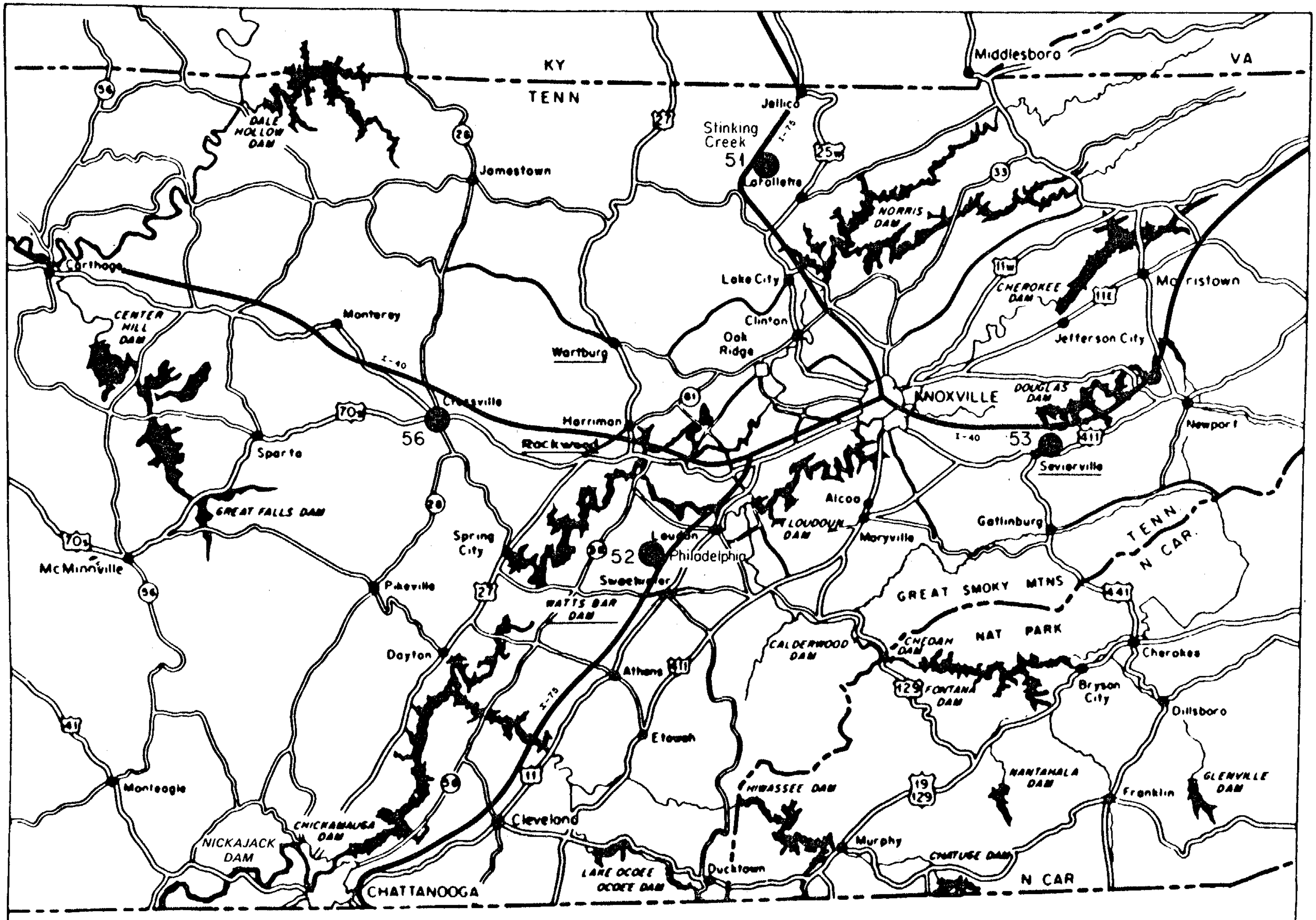

Fig. 4.7. Remote environs milk-sampling stations.

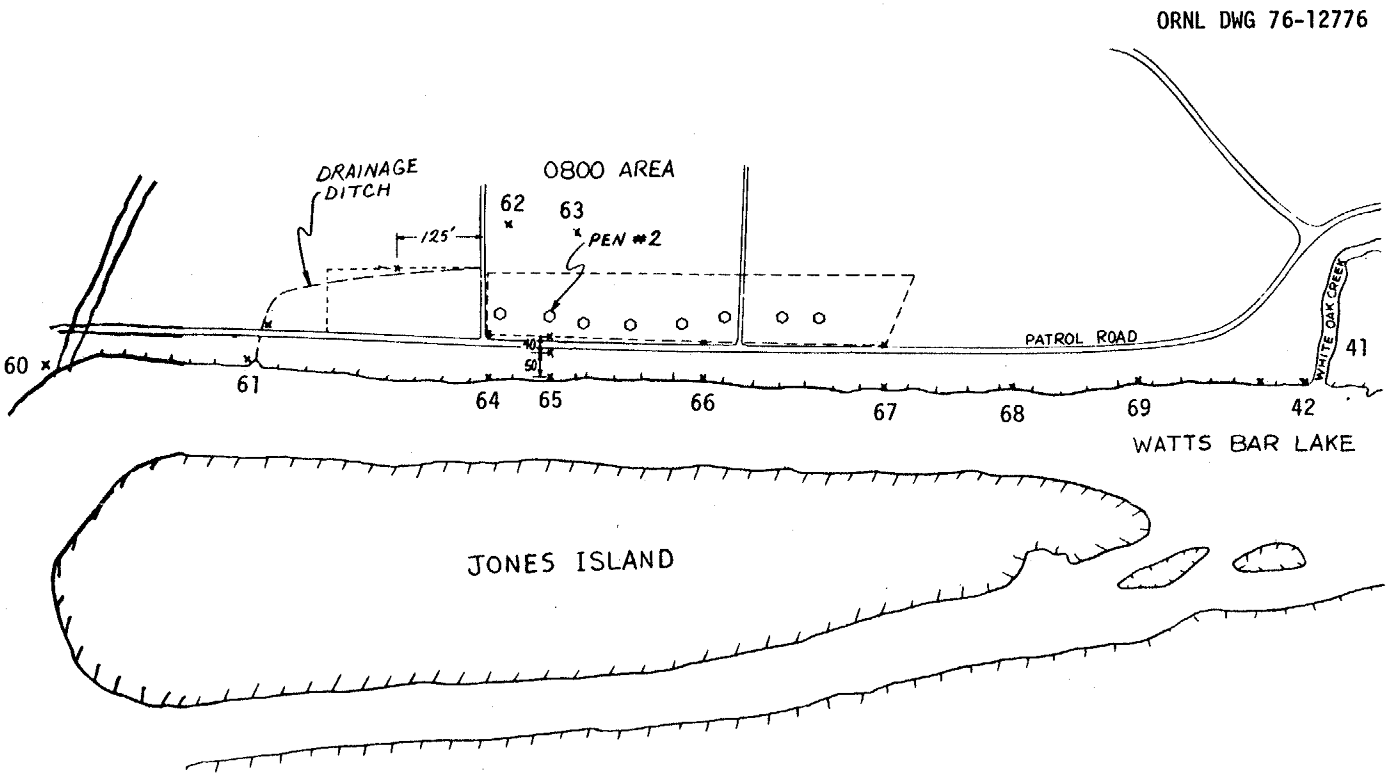

Fig. 4.8. Thermoluminescent dosimeter locations along the perimeter of the DOE-controlled area.

Soil and grass samples are collected semiannually and annually, respectively, from locations near the PAM and RAM stations and semiannually at LAM station 16. Soil and grass samples are collected at each station, composited, and analyzed by gamma spectroscopy and radiochemical techniques for uranium, plutonium, and various other radioisotopes.

4.2 ENVIRONMENTAL MANAGEMENT FUNCTIONS

The major Environmental Management functions during 1982 were

- coordinating the Laboratory's pollution abatement and monitoring programs;
- serving as liaison between the various ORNL groups involved in pollution control, the ORNL management, and the UCC-ND Office of Safety and Environmental Protection;
- determining the pollutants (radioactive and nonradioactive) to be monitored in effluents and environmental media and the location and frequency of the measurements;
- identifying areas where development work, additional monitoring equipment, and changes in waste disposal practices are required for pollution abatement;
- maintaining adequate records on significant effluents within the installation;
- reviewing, or providing for review, the design, acquisition, and installation of required pollution control equipment;
- preparing environmental assessments for those ORNL construction projects that require them;
- preparing monthly, quarterly, and annual reports on radioactive and nonradioactive effluents as required by UCC-ND management and DOE; and
- reviewing ORNL construction projects for environmental impact.

4.3 ATMOSPHERIC MONITORING

4.3.1 Air Concentrations

The average concentrations of alpha radioactivity in the atmosphere, as measured with filters from the LAM, PAM, and RAM networks during 1982 follow.

Network	Concentration	
	Bq/m^3	$\mu Ci/cc$
LAM	0.82E−04	0.22E−14
PAM	0.36E−04	0.98E−15
RAM	0.34E−04	0.95E−15

All networks are less than 11% of 0.74E−3 Bq/m^3 (2.0E−14 $\mu Ci/cc$), the average concentration guide (CG_a)[1] for a mixture of airborne uranium isotopes in an uncontrolled area.

1. DOE Order 5480.1, Chap. XI.

The average concentrations of beta radioactivity in the atmosphere, as measured with filters from the LAM, PAM, and RAM networks during 1982, follow.

Network	Concentration	
	Bq/m^3	$\mu Ci/cc$
LAM	0.16E−02	0.43E−13
PAM	0.89E−03	0.24E−13
RAM	0.82E−03	0.22E−13

Based on an occupational exposure of 1.1E−2 Bq/m^3 (3E−9 $\mu Ci/cc$), the LAM network value of 0.16E−03 Bq/m^3 (0.43E−13 $\mu Ci/cc$) is less than 0.002% of the CG_a. Both the LAM and PAM network values represent <0.04% of the CG_a of 3.7 Bq/m^3 (1.0E−10 $\mu Ci/cc$) applicable to releases to uncontrolled areas.

4.3.2 Fallout (Gummed Paper Technique)

The average activity per square meter (square foot) on gummed paper for the three air-monitoring networks for 1982 was 9.6E−01 Bq/m^2 (2.4E−06 $\mu Ci/ft^2$) as compared to 1.8 Bq/m^2 (4.4E−06 $\mu Ci/ft^2$) for 1981.

4.3.3 Rain Out (Gross Analysis of Rainwater)

The average concentration of beta radioactivity in rainwater collected from the three networks during 1982 follows.

Network	Concentration	
	Bq/m^3	$\mu Ci/cc$
LAM	0.24E−3	0.65E−08
PAM	0.18E−3	0.48E−08
RAM	0.29E−3	0.78E−08

4.3.4 Atmospheric Radioiodine (Charcoal Cartridge Technique)

Atmospheric iodine sampled at the PAM stations averaged 0.37E−04 Bq/m^3 (0.10E−14 $\mu Ci/cc$) during 1982. This average represents <0.005% of the concentration guide of 3.7 Bq/m^3 (1E−10 $\mu Ci/cc$) applicable to inhalation of ^{131}I released to uncontrolled areas. The maximum concentration observed for one week was 0.47E−04 Bq/m^3 (0.13E−14 $\mu Ci/cc$).

The average radioiodine concentration at the LAM stations was 0.13E−03 Bq/m^3 (0.34E−14 $\mu Ci/cc$). This concentration is <0.001% of the concentration guide for inhalation by occupational personnel. The maximum concentration for one week was 0.50E−03 Bq/m^3 (0.14E−13 $\mu Ci/cc$) .

In general, the level of radioactivity for the specific radionuclides in air for 1982 was lower than the values reported for 1981. This correlated with less fallout in 1982 from weapons testing.

4.3.5 Nonradioactive Air Particulates

Suspended air particulates are measured at air monitoring stations 1, 3, 6, 7, and 15 (Fig. 4.1). The method for the determination of suspended particulates is the high-volume method recommended by the Environmental Protection Agency (EPA). The average annual geometric mean of the stations was 36 $\mu g/m^3$, which is 48% of the Tennessse Air Pollution Control Regulation's primary standard and approximately the same as the results for the previous years.

4.3.6 Milk Analysis

The yearly average and maximum concentrations of ^{131}I in raw milk from the immediate and remote environs was less than the minimum detectable concentration of ^{131}I in milk [17.0 mBq/L (0.45 pCi/L)]. The concentrations of ^{90}Sr in milk from both the immediate and remote environs of ORNL are about the same as reported for 1981 and are within the FRC Range.

4.3.7 ORNL Stack Releases

The radionuclide releases from ORNL stacks are summarized in Table 4.1.

4.4 WATER MONITORING

4.4.1 White Oak Lake Waters

As shown in Fig. 4.9, the 1982 discharges of the most significant radionuclides to the Clinch River were up from 1981. Table 4.2 shows all of the measured radioisotopes discharged during 1982. Trends in the total CG_w levels in the Clinch River are presented in Fig. 4.10. Water samples for the analysis of nonradioactive substances are collected at the same locations as those for radioactive water sampling. All samples are composited from monthly analyses. Samples are analyzed for a variety of water quality parameters related to process release potential and background information needs by analytical

Table 4.1. Annual discharges of radionuclides to the atmosphere

Stack	^{3}H		^{85}Kr		^{131}I		^{133}Xe		Unidentified alpha	
	TBq	kCi	TBq	kCi	GBq	Ci	TBq	kCi	kBq	μCi
2026					≤7.0E−3	≤1.9E−4				
3020					≤5.9E−3	≤1.6E−4				
3039	695	18.8	340	9.2	≤6.2E−3	≤1.7E−4	1660	45		
7025	7.8	0.21								
7911			94	2.5	≤4.0	≤1.1E−1	460	12.4		
Transuranic Laboratory									93	2.5
4508									7.8	0.2
Total	703	19	434	12	≤4.1	≤1.3E−1	2120	57	101	2.7

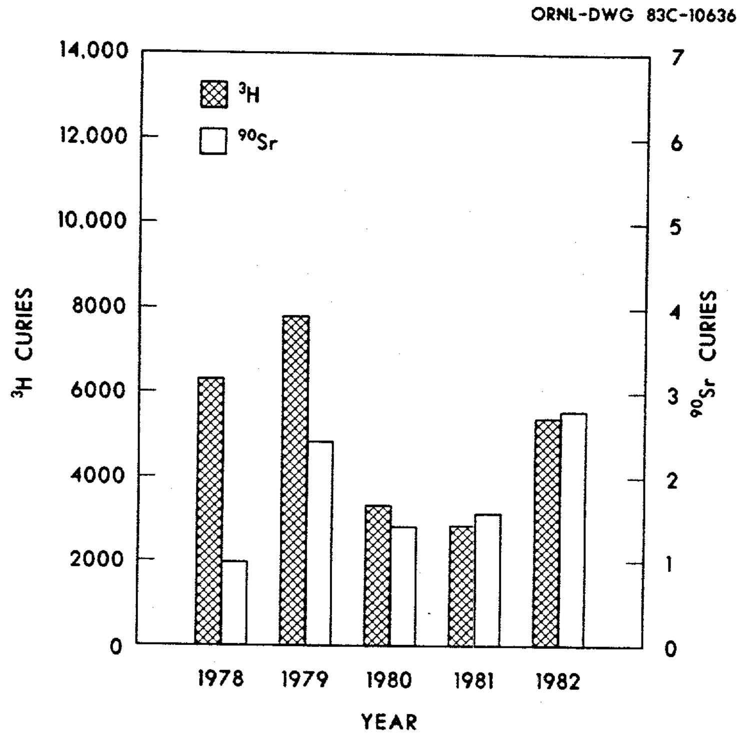

Fig. 4.9. Curies discharged over White Oak Dam. (To convert curies to terabecquerels, multiply curies by 0.037.)

Table 4.2. Discharge of radionuclides to the Clinch River in 1982

^{90}Sr		^{106}Ru		^{137}Cs		Transuranic alpha		^3H	
TBq	Ci	TBq	Ci	TBq	Ci	TBq	Ci	TBq	Ci
0.10	2.7	0.008	0.21	0.05	1.4	0.001	0.03	199	5370

4.34

procedures recommended by the EPA. Table 4.3 shows percentages of water quality compliance with the National Pollutant Discharge Elimination System (NPDES).

4.4.2 Potable Water

The average quarterly concentrations of ^{90}Sr in potable water at ORNL during 1982 follow.

Quarter No.	Concentration	
	Bq/L	μCi/mL
1	0.30E−1	0.81E−9
2	0.20E−1	0.54E−9
3	0.75E−1	0.20E−8
4	0.40E−1	0.11E−8
Average	0.41E−1	0.11E−8

ORNL-DWG 83C-10635A

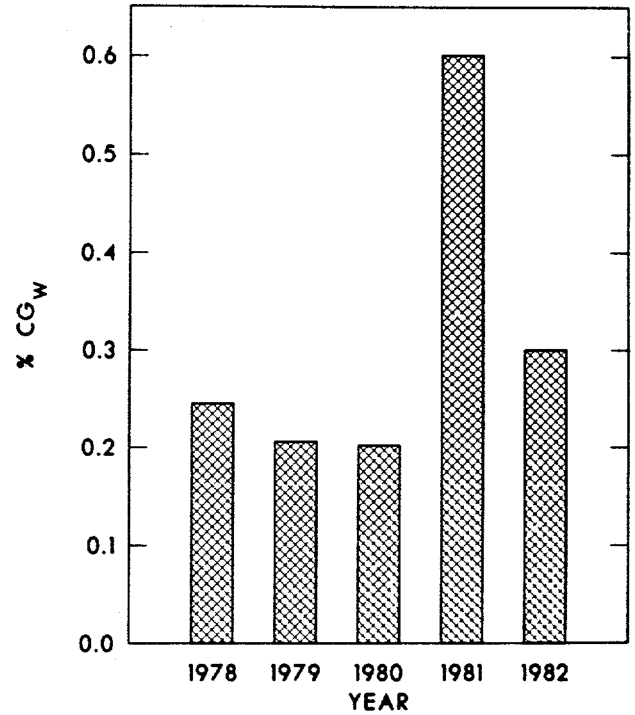

Fig. 4.10. Total CG_w levels discharged over White Oak Dam.

The average value of 0.41E−1 Bq/L (0.11E−8 μCi/mL) represents 0.4% of the CG_w for drinking water applicable to individuals in the general population.

4.4.3 Clinch River Fish

Results of radionuclide analyses of the fish samples taken in the 1982 fish-sampling program showed that the percentage of maximum permissible intake (MPI)[2] was lower than that calculated for 1981 (maximum less than 1% of MPI). Calculations of the estimated dose to an adult individual during 1982 due to consumption of 16.8 kg of bluegill taken from CRM 20.8 showed lower total-body and critical organ doses than found in 1981 (Sect. 4.8.1). The concentrations of mercury found in the fish taken from CRM 12.0 (mouth of Poplar Creek) averaged somewhat higher than that measured for 1981, with a maximum of 56% of the action level.[3]

4.5 RADIATION BACKGROUND MEASUREMENTS

The data on external gamma radiation background measurements showed only small differences in the data reported for 1981.[4] The difference between the average levels in the perimeter and the remote

2. MPI = intake of radionuclide from eating fish—calculated to be equal to a daily intake of 2.2 L of water over a period of one year, containing the concentration of radionuclides in question. Consumption of fish is assumed to be 16.8 kg/year of the species in question. Only man-made radionuclides were used in the calculation.

3. Percentage of proposed Food and Drug Administration (FDA) mercury action level in fish of 1000 ng/g.

4. J. A. Auxier and T. W. Oakes, *Industrial Safety and Applied Health Physics Division Annual Report for 1981*, ORNL-5859, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., 1982.

Table 4.3. National Pollutant Discharge Elimination System (NPDES) experience for ORNL, 1982

Discharge point	Effluent parameters	Effluent limits (mg/L)		Percentage measurements in compliance
		Daily average	Daily maximum	
001 (White Oak Creek)	Dissolved oxygen, minumum	5		100
	Dissolved solids		2000	100
	Oil and grease	10	15	85
	Chromium, total		0.05	100
	pH		6.0–9.0	99
002 (Melton Branch)	Chromium, total		0.05	100
	Dissolved oxygen, minimum		0.05	100
	Dissolved solids		2000	100
	Oil and grease	10	15	100
	pH		6.0–9.0	99
003 (main sanitary treatment facility)	Ammonia, nitrogen		5	35
	BOD[a]		20	73
	Chlorine residual		0.5–2.0	97
	Fecal coliform bacteria, No./100 mL	200[b]	400[b]	83
	pH		6.0–9.0	100
	Suspended solids		30	98
	Settleable solids, mL/L		0.5	96
004 (7900 area sanitary treat-ment facility	BOD		30	No discharges from this facility
	Chlorine residual		0.5–2.0	
	Fecal coliform bacteria, No./100 mL	200[b]	400[c]	
	pH		6.0–9.0	
	Suspended solids		30	
	Settleable solids, mL/L		0.5	

[a]BOD = biochemical oxygen demand.
[b]Monthly average.
[c]Weekly average.

environs is considered to be within the variation in background normally experienced in eastern Tennessee; the difference is dependent on elevation, topography, and the geological character of the surrounding soil.[5]

4.6 SOIL AND GRASS SAMPLES

The data on the soil and grass measurements showed no major differences compared to the data reported for 1981.[4]

5. T. W. Oakes, K. E. Shank, and C. E. Easterly, "Natural and Man-Made Radionuclide Concentrations in Tennessee Soil," pp. 323–33 in *Proceedings of the Health Physics Tenth Midyear Topical Symposium,* Sarasota Springs, New York, October 11–13, 1976.

4.7 DEER SAMPLES

Occasionally, deer are killed by automobiles on the DOE reservation. Forty-eight vehicle-killed deer were analyzed during 1982 for gamma emitters. The level of radioactivity found in the muscle and liver of the deer was comparable to that reported for 1981.[4] (Note that hunting is illegal on the reservation.)

4.8 CALCULATION OF POTENTIAL RADIATION DOSE TO THE PUBLIC

Potential radiation doses resulting from plant effluents were calculated for a number of dose reference points within the Oak Ridge environs. All significant sources and modes of exposure were examined, and a number of general assumptions were used in making the calculations. The site boundary for the Oak Ridge complex was defined as the perimeter of the DOE-controlled area.

Gaseous effluents are discharged from several locations within ORNL. For our calculations, the gaseous discharges were assumed to occur from only one vent. Concentrations of radionuclides contained in the air and deposited on the ground were estimated at distances up to 50 miles (80 km) from the Oak Ridge facilities using a Gaussian plume model developed by Pasquill[6] and Gifford[7] incorporated in a computer program AIRDOS.[8] The concentration was averaged over the crosswind direction to give the estimated ground-level concentration downwind of the source of emission. The deposition velocities used in the calculations were 0.0 cm/s for krypton and xenon, 0.2 cm/s for iodine, and 0.1 cm/s for particulates.

Exposures to radionuclides originating in the effluents released from the Oak Ridge facilities were converted to estimates of radiation dose to individuals using models and data presented in publications of the International Commission on Radiological Protection, other recognized literature on radiation protection, personal communication, and computer programs incorporating some of these models and data. Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until removed by processes of metabolism and radioactive decay; thus, the estimates for internal dose are called dose commitments. They are obtained by integration over an assumed working lifetime of 50 years for the exposed individual.

Radiation doses to the total body and to internal organs from external exposures to penetrating radiation are approximately equal; however, doses to individual organs may vary considerably because some radionuclides concentrate in certain organs. For this reason, in estimating radiation dose to the total body, thyroid, lungs, bone, liver, kidneys, and gastrointestinal tract, various pathways of exposure were considered. These estimates were based on parameters applicable to an average adult. The population dose estimate in [person-Sv (person-rem)] is the sum of the total-body doses to exposed individuals within an 80-km (50-mile) radius of the Oak Ridge facilities.

4.8.1 Maximum Potential Exposure

The point of maximum potential exposure ("fence-post" dose) on the site boundary is located along the bank of the Clinch River adjacent to a cesium field experimental plot and is due primarily to "sky

6. F. Pasquill, *Atmospheric Diffusion,* D. Van Nostrand Co., Ltd., London, 1962.

7. F. A. Gifford, Jr., *The Problem of Forecasting Dispersion in the Lower Atmosphere,* U.S. AEC, DTI, Oak Ridge, Tenn., 1962.

8. R. E. Moore et al., *AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides,* EPA 520/1-79-009, Washington, D.C., 1979.

shine" from the plot. A maximum potential whole-body dose of 1.8 mSv/year (178 mrem/year) was calculated for this location, assuming that an individual remained at this point for 24 h/d for the entire year. The calculated maximum potential exposure is 36% of the allowable standard.[1] This is an atypical exposure location, and the probability of an exposure of the magnitude calculated is considered remote since access is only by boat.

The total-body dose to a "hypothetical maximum exposed individual" at the same location was calculated using a more realistic residence time of 240 h/year. The calculated dose under these conditions was 0.05 mSv/year (4.9 mrem/year), which is 1.0% of the allowable standard and represents what is considered a probable upper limit of exposure. A more probable exposure potential might be considered to occur at other locations beyond the site boundary as a result of airborne or liquid effluent releases.

The dose commitment to an individual continuously occupying the residence nearest the site boundary would result from inhalation and ingestion; an inhalation rate of 2E4 L/d for the average adult is used. Calculated dose commitments at this location were 0.087 mSv (8.7 mrem) ± 300% to the lung (the critical organ) and 0.0019 mSv (1.9 mrem) ± 300% to the total body; ^{234}U is the important radionuclide contributing to this dose. These levels are 0.58% and 0.38%, respectively, of the allowable annual standard. The large error bounds are due to the uncertainties in the meteorological and source-term data and modeling assumptions.

An important contribution to dose from radioactivity within the food chain comes from the atmosphere-pasture-cow-milk pathway. Measurements of two principal radionuclides entering this pathway, ^{90}Sr and ^{131}I, indicate that the maximum dose to an individual in the immediate environs from ingestion of 1 L/d of milk is 0.0002 mSv (0.02 mrem) to the total body and 0.01 mSv (1.2 mrem) to the bone at station 4 (see Fig. 4.6). The average concentrations for the remote stations were assumed to be background and were subtracted from the perimeter station data in making the calculations.

The public water supply closest to the liquid discharges from the Oak Ridge facilities is located about 26 km (16 miles) downstream at Kingston. Measurements of treated river water samples at Kingston indicate that all measurements of isotopes were less than background radiation in untreated water taken from Melton Hill Lake.

Estimates of the 50-year dose commitment to an adult were calculated for consumption of 16.8 kg (37 lb) of fish per year from the Clinch River. This amount is about 2.5 times the national average fish consumption and is used because of the popularity of fishing in eastern Tennessee. From the analysis of edible parts of the fish examined, the maximum organ dose commitment to an individual from the bluegill samples taken from CRM 20.8 is estimated to be 0.21 mSv (21 mrem) to the bone from ^{90}Sr. The maximum total-body dose to an individual was calculated to be 0.05 mSv (5.3 mrem) from ^{137}Cs. These doses are 1.5% and 1.1%, respectively, of the allowable standard. Fish samples taken from above Melton Hill Dam were analyzed to determine background conditions.

If the fish bones were consumed, the projected dose commitments would be higher than those shown in this report. Strontium concentrates in the bone, and preliminary test results indicate that the dose commitment from eating 1 kg (2.2 lb) of fish with bone would be greater by a factor of 3–30 than that from eating 1 kg (2.2 lb) of boneless fish. This possibility is of interest because commercial fishermen may catch carp, which is then processed into fish patties that include the bone.

Summaries are given in Table 4.4 of the potential radiation doses to adults in the general public at the points of highest potential exposure from gaseous and liquid effluents from the Oak Ridge facilities.

Table 4.4. Summary of the estimated radiation dose to an adult individual during 1982 at locations of maximum exposure

Pathway	Location	Dose [μSv (mrem)]	
		Total body	Critical organ
Gaseous Effluents			
Inhalation, direct radiation from air and ground, and food chains	Nearest resident to site boundary	19 (1.9)	87 (8.7) (lung)
Terrestrial food (milk only)	Milk sampling stations (^{90}Sr)	0.2 (0.02)	12 (1.2) (bone)
Liquid Effluents			
Aquatic food chains (fish)	Clinch-Tennessee River System (^{90}Sr)	4.3 (0.43)	210 (21) (bone)
Drinking water[a]	Kingston, Tennessee (^{90}Sr)	*b*	
Direct radiation water, shores, and mud flats[c]	Downstream from White Oak Creek near experimental cesium field plots	49 (4.9)	49 (4.9) (total body)

[a]Based on the analysis of processed water.

[b]All isotopes in the treated Kingston water were less than those in the untreated background water taken from Melton Hill Lake.

[c]Assuming a resident time of 240 h/year.

4.8.2 Dose to the Population

The Oak Ridge population received the largest average individual total-body dose as a population group. The average yearly total-body dose to an Oak Ridge resident was estimated to be 0.0009 mSv (0.09 mrem), compared with about 1 mSv (100 mrem) from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.004 mSv (0.44 mrem). The maximum potential dose commitment to an Oak Ridge resident was calculated to be 0.087 mSv (8.7 mrem) to the lung. This calculated dose is 0.58% of the allowable annual standard.

The cumulative total-body dose to the population within a radius of 80 km (50 miles) of the Oak Ridge facilities resulting from 1982 plant effluents was calculated to be 0.50 person-mSv (50 person-rem). This dose may be compared with an estimated 870 person-Sv (87,000 person-rem) to the same population resulting from natural background radiation. About 10% of the collective 80-km (50-mile) population dose from the effluents of the Oak Ridge facilities is estimated to be absorbed by the Oak Ridge population.

4.9 SUMMARY OF THE MAJOR ACTIVITIES OF THE DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

4.9.1 Environmental Data Assessment Group

The Environmental Data Assessment Group is responsible for assembling, processing, reporting, and assessing the major portion of the environmental monitoring data within ORNL plant boundaries and for off-site monitoring of the Oak Ridge DOE Reservation. This includes the processing of more than 6000 samples and 9000 analyses annually. Table 4.5 shows a summary of a majority of the routine samples for which data were processed and reported.

The group has been involved in nonroutine assessment projects, such as proposed incinerator projects, a synthethic fuels project (for Battelle Columbus Laboratories), and the impact of new regulations on assessment. The synthetic fuels project required an evaluation of the impact on the nearest resident from the discharge of 36 radionuclides.

The group is responsible for developing QA procedures for all aspects of the monitoring program, including field sampling, laboratory analyses, data entry and verification, and reporting. The Method and Procedures Manual used by the DEM for environmental monitoring is being revised and updated to reflect new and improved techniques. During the year, laboratory equipment was developed and assembled to allow automatic concentration of liquid samples. This improvement has reduced the required labor and has ensured the quality of the samples.

The QA of data entry and verification involves the use of a commercial software package for direct key-to-disk data entry, full-screen editing, and rekey verification. The DEM is testing a series of programs for electronically transferring data from ORNL's Analytical Chemistry Division to a centralized data base for analysis and report preparation.

The group is responsible for the design and implementation of an environmental monitoring information system that will combine and integrate DEM's numerous data resources into a single, centralized data base from which statistical analyses, graphics, and reports can be easily generated. The information system covers five major areas: (1) centralization of data; (2) QA of data; (3) sample and inventory tracking; (4) analysis, graphics, and report program development; and (5) documentation.

The group has been responsible for the evaluation and relocation, where necessary, of perimeter air monitors. This evaluation includes the implementation of a dispersion model (IMPACT), the development of a complex terrain data base, the integration of real-time meteorological data from ORNL into the program, and the graphic display of the results. Upon completion of the project, the DEM will have an improved capability for evaluating the impacts of releases from any of the three major facilities on the Oak Ridge Reservation in an emergency situation.

The group has expanded the role of the bar-code reader system to include its use in the field for recording on-site measurements. The data can then be off-loaded onto one of ORNL's mainframe computers for analysis. The bar-code printer has also been used to generate labels for sampling containers. This will provide the interface to the sample tracking system, which is being developed.

The group has been responsible for the digitizing of all DEM's sampling stations in order to produce computer-generated maps for summarizing spatially related data. The group has also been involved in the upgrading of two water-sampling stations. A fixed sampler, which refrigerates the NPDES samples, replaced a portable sampler at the sewage treatment plant. A sonic water-level measurement system was included in the upgrade to provide more accurate and reliable flow measurements. A similar type upgrade was provided to monitor liquid effluents from the Building 1505 area.

4.9.2 Environmental Protection Group

The main function of the Environmental Protection Group is to coordinate input to all ORNL divisions and to the UCC-ND Engineering Division regarding the potential environmental impacts of proposed projects (e.g., providing criteria, technical review, project description and memoranda and submitting required permit applications). Other functions include departmental planning and QA for

Table 4.5. Environmental monitoring on the Oak Ridge Reservation

Type	Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
Air	39	Continuous	Weekly	Weekly	Gross alpha, gross beta, rainout, ^{131}I, ^{3}H
	3	Continuous	Weekly	Quarterly	Specific radionuclides
	22	Continuous	Continuous	Continuous	Fallout beta-gamma, alpha
	5	24 h	Bimonthly	Bimonthly	Suspended particulates
	39	Continuous	Continuous	Continuous	Gross particulate beta-gamma
Stack releases	5	Continuous	Weekly	Weekly	Gross alpha,[a] gross beta,[a] 8-d gross alpha,[b] 8-d gross beta,[b]
	1	Continuous	3 times/week	3 times/week	^{131}I
Stream water	1	Continuous	Weekly	Weekly	Gross alpha, gross beta, ^{3}H, ^{90}Sr, ^{60}Co, ^{106}Ru, ^{137}Cs, ^{238}Pu, transplutonium
	4	Grab	Monthly	Monthly	Cr, Zn, NO_3(N), Hg
	1	Continuous	Weekly	Monthly	Gross alpha, ^{3}H, ^{60}Co, ^{137}Cs, ^{106}Ru
	1	Continuous	Continuous	Continuous	Gross beta-gamma
	1	Continuous	Weekly	Monthly	^{238}U, Pb, SO_4, TDS, Cd, Cr, Cn, NO_3(N), Zn, F, Hg, Ni
	2	Continuous	Weekly	Quarterly	^{90}Sr, ^{60}Co, ^{137}Cs, ^{3}H
	1	Continuous	Weekly	Bimonthly	Hg
	1	Grab	Daily	Quarterly	^{3}H, ^{60}Co, ^{137}Cs, ^{90}Sr, gross alpha, gross beta
Discharge water (NPDES)	1	Daily	Daily	Daily	pH, Cl, flow
	2	Daily	Daily	Daily	pH, DO,[c] temperature, flow
	1	Weekly	Weekly	Weekly	Volatile solids, suspended solids
	3	Weekly	Weekly	Weekly	Settleable solids, BOD,[d] suspended solids, NH_4, COD, Cr
	1	Monthly	Monthly	Monthly	NH_4, kjeldahl nitrogen, fecal coliform
	2	Monthly	Monthly	Monthly	Total dissolved solids, oil, grease
Fish	4	Annually	Annually	Annually	^{90}Sr, ^{137}Cs, ^{60}Co, ^{40}K, ^{238}Pu, ^{239}Pu, ^{234}U, ^{235}U, ^{238}U, Hg
	1	Quarterly	Quarterly	Quarterly	^{90}Sr, ^{137}Cs, ^{60}Co, ^{40}K, ^{238}Pu, ^{239}Pu, ^{234}U, ^{235}U, ^{238}U, Hg

Table 4.5. (continued)

Type	Number of stations	Sampling period or type	Sampling frequency	Analysis frequency	Analyses
Soil	16	Semiannually	Semiannually	Semiannually	^{90}Sr, ^{137}Cs, ^{239}Pu, ^{238}U
Grass	16	Annually	Annually	Annually	^{90}Sr, ^{137}Cs, ^{239}Pu, ^{238}U
Deer	As available	As available	As available	As available	^{137}Cs
Milk	7	Weekly	Weekly	Weekly	^{90}Sr, ^{131}I
	5	Bimonthly	Bimonthly	Bimonthly	^{90}Sr, ^{131}I
TLDs[e]	10	Monthly	Monthly	Monthly	External gammas
	122	Quarterly	Quarterly	Quarterly	External gammas
	117	Semiannually	Semiannually	Semiannually	External gammas
Groundwater	100	Quarterly	Quarterly	Quarterly	^{3}H, ^{90}Sr, ^{137}Cs, ^{60}Co, COD,[f] TDS,[g] anions
	12	Quarterly	Quarterly	Quarterly	Metals, volatile organics, pesticides, kjeldahl nitrogen, NH_3, TOC,[h] oil, grease phenols, PAHs, BOD, fecal coliform, asbestos
Wastewater	12	Grab	Daily	Monthly	^{90}Sr, gross alpha, gross beta, gamma scan
	1	Grab	Monthly	Monthly	Gross alpha, gross beta, gamma scan
	6	Grab	Monthly	Monthly	Hg, NO_3, P, Zn, Cr
	3	Grab	Quarterly	Quarterly	^{137}Cs, ^{60}Co, gamma scan

[a]Samples are counted within 24 h of collection.
[b]Samples are recounted after an 8-d decay period.
[c]DO = dissovled oxygen.
[d]BOD = biochemical oxygen demand.
[e]TLD = thermoluminescent dosimeters.
[f]COD = chemical oxygen demand.
[g]TDS = total dissolved solids.
[h]TOC = total organic carbon.
[i]PAH = polycyclic aromatic hydrocarbons.

intradepartment activities. The group also provides support to other UCC-ND facilities in the area of project input and to UCC for Clark Center Recreational Park.

During 1982, the group fulfilled its main function by routine contacts with the Engineering Division on proposed projects. Documentation required by the National Environmental Policy Act (NEPA) was prepared for 17 projects proposed at ORNL. The group also coordinated departmental input for an environmental analysis document for ORNL as a whole. The group provided input for ORNL to the Engineering Division's Environmental Project Review, which was prepared at the request of UCC-ND's Office of Health, Safety, and Environmental Affairs.

The group made significant progress on projects that the DEM is sponsoring. For example, a meteorological monitoring system at ORNL was installed in 1982. The Hazardous Waste Storage Facility entered its construction phase, and a permit application for the storage of hazardous chemicals at this facility was completed and submitted during 1982. Finally, the group coordinated the state approval and installation of a sewage collection system at Clark Center Recreational Park.

Progress was also made in obtaining approval for other departmental projects, including the following:

- the replacement of ORNL's PAM network (funding approved; construction to begin in 1983),
- criteria development for a new monitoring system at the 3039 stack (funding approved in 1983), and
- submittal of two line-item requests to replace the ORNL Sewage Treatment Plant and to install new environmental monitoring equipment.

In the area of equipment procurement, the following pieces of instrumentation were received and installed during 1982:

- a sulfur dioxide monitor located at LAM station 7,
- a radiation monitoring cart that will be used at the 3039 stack,
- a water monitor located at the discharge of ORNL's coal yard runoff treatment system, and
- a PDP 11/40 computer that will be used to collect data from the new monitoring stations that are being installed.

Planning was a final effort for which the group provided input. The group took a leading role in the preparation of the Five-Year Environmental Project Plan for the DEM. Major input was also provided for ORNL's Spill Prevention, Control, and Countermeasures Plan, including an updated storm-drain schematic for Bethel Valley. Finally, the group completed the telecommunications long-range plan for the entire division.

4.9.3 Environmental Surveillance Group

The Environmental Surveillance Group of the DEM provides field and laboratory support for environmental monitoring and sampling activities (see Table 4.5). This group is involved in the collection of hundreds of environmental samples, the acquisition of field data, the preparation of samples, and related activities. Types of samples collected include atmospheric, aquatic, terrestrial, biological, and food stuff (e.g., air, rainwater, surface water, groundwater, particulate matter, milk, soil, vegetation, insects, fish, and others). The sampling frequency can be daily, weekly, monthly, quarterly, or yearly, depending upon the environmental media and the monitoring parameters.

In addition to routine monitoring and sampling activities, the Environmental Surveillance Groups also conducted special programs in the following areas:

- assisted the Environmental Sciences Division with the vehicle-killed deer pickup and autopsy program;
- implemented a new radiation-monitoring program of contaminated areas;
- collected, prepared for analysis, and reported data on special soil and grass samples from the center of the Oak Ridge Reservation;
- assisted with special sampling of the ORNL Sewage Treatment Plant;
- provided support for an insect study conducted on the shale-fracture pond;
- implemented the use of the bar code printer and reader for sample labeling and collection of field data;
- completed a surface water characterization program; and
- prepared emergency sampling kits.

The Environmental Surveillance Group also provides monitoring and sampling activities for K-25, Y-12, and the Paducah Gaseous Diffusion Plant (PGDP). These programs include

- soil and vegetation samples for Y-12;
- TLDs for PGDP and K-25;
- wildlife and vegetation samples for PGDP; and
- data from PAM stations, fish and water samples from the Clinch River, and other types of samples primarily collected for ORNL which are provided to Y-12 and K-25 for their use.

4.9.4 Hazardous Materials Disposal Group

The primary function of this group is to ensure the efficient and cost-effective management of hazardous waste materials according to all applicable state and federal regulations, health and safety guidelines, and DOE orders. The main avenues available for meeting this responsibility are the Hazardous Materials Management and Control Manual and specific procedures found in the ORNL Environmental Protection Manual. These two manuals provide guidelines for the procurement, use, storage, transportation, and disposal of hazardous materials.

Chemical Waste Disposal

During 1982, about 450 waste disposal requests were handled by the Hazardous Materials Disposal Group (Fig. 4.11). These disposal requests represent approximately 130,000 kg of hazardous waste generated at the Laboratory and the ORNL facilities at Y-12 (Fig. 4.12). During the year there were three shipments of hazardous waste to off-site commercial facilities for disposal.

Recycle/Recovery Operations

A new treatment process for recovering silver metal from photo-reproduction wastes was developed and large-scale recovery operations commenced during 1982. Approximately 11,000 L of silver-bearing wastes were processed. Plans are to expand this process for recovering silver from other waste streams as well. The recovered silver is turned over to the Laboratory Precious Metals Coordinator for resale on the open market.

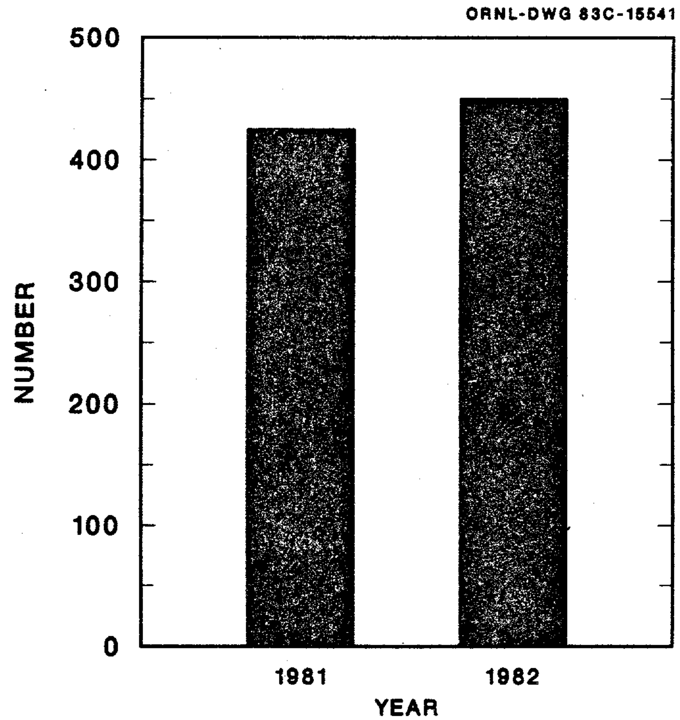

Fig. 4.11. Disposal requests processed by the Hazardous Materials Control and Waste Disposal Group.

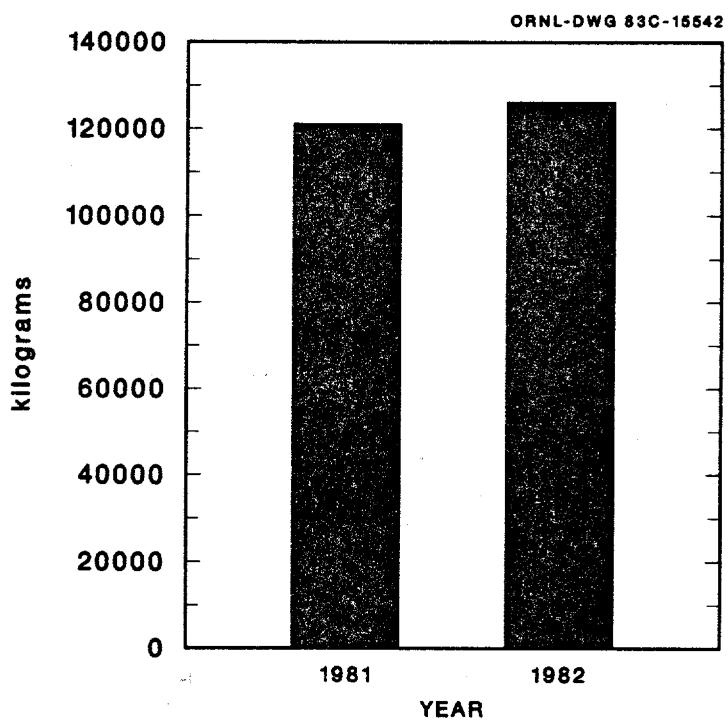

Fig. 4.12. Hazardous waste totals.

Noncontaminated waste oil operations at the Laboratory resulted in the recycling of approximately 37,850 L of waste oil. This oil is sold to an off-site contractor.

Hazardous Materials Tracking System (HMTS)

This is an on-line, user-friendly information system designed to aid the DEM staff at ORNL in maintaining inventory records of hazardous chemicals and hazardous waste. The system is processed on the DECsystem-10 computer at ORNL—with System 1022 as the data-base management system and SCOPE as the system screen processor. DEM utilizes the services of an INTERMEC S-Series bar-code printer to generate bar-code labels for the chemicals procurred at ORNL.

The HMTS provides file maintenance capability, record query, and management information reporting. File maintenance consists of data entry, editing, and transaction processing. Extensive data validation is done to ensure the integrity of the system's data files. Record query of the inventory files allows the user to display data on the screen based on user selection criteria very similar to stand-alone system 1022 selection. The management information reports are generated upon user request and specifications through the system. Output in most cases can be to the terminal or to a disk file for subsequent printing.

Work on the computerized tracking system for hazardous chemicals has proceeded during the year. The waste disposal program is currently functional and being utilized to generate hazardous waste activity reports that are then submitted to DOE and state environmental personnel. The program has also been instrumental in preparing necessary shipping documents for off-site waste shipments. It is hoped that the entire system will become operational during 1983.

5. Safety Department

M. W. Knazovich

J. F. Alexander	M. F. Fair
J. S. Brown	L. L. Huey
G. H. Burger	H. M. Lockhart
B. F. Burns	R. E. Millspaugh
D. T. Dice	

5.1 INDUSTRIAL SAFETY AND SPECIAL PROJECTS

The Industrial Safety and Special Projects Section is responsible for developing and implementing accident prevention and loss management programs within the Laboratory. The staff provides consultation and assistance in matters concerning industrial safety and participates in inspection and evaluation programs to assess the level of safety in various ORNL activities. The staff participates in a variety of safety-related activities, including developing safety policies and procedures, reviewing engineering drawings for safety content, and providing safety orientation and specialized safety education programs. The group maintains a library of DOE-prescribed safety standards, safety reference material, and audiovisual aids. The section also provides Laboratory-wide on- and off-the-job safety promotion activities. Whenever an injury or accidental property loss occurs, the safety staff is involved in the investigation, analysis, classification, and documentation of the incident. The safety staff also provides support to ORNL's Construction Engineering Section in carrying out the construction safety program.

The Industrial Safety and Special Projects Section assists management in the formulation and direction of the Laboratory's safety program and in developing and maintaining a high level of safety awareness among all Laboratory employees through a program consistent with UCC-ND and UCC safety policies.

5.1.1 Industrial Safety Activities

The safety staff assists the management line organization and Laboratory personnel in all areas relating to personnel safety and accident prevention. A principal function is to help Laboratory division representatives in the development of action plans to adequately meet safety requirements. Included in the action plans are the routine activities normally associated with a successful safety program—that is, (1) conducting safety meetings and safety inspections; (2) investigating, analyzing, and reporting all accidents and near misses; (3) formulating and issuing policies, guides, procedures, and standards; (4) providing education and training services; (5) conducting periodic safety performance appraisals; (6) seeking to improve off-the-job safety performance; and (7) preparing records and reports. The staff performs quarterly evaluations of each Laboratory division's safety performance in these and other areas. Safety action plans for all Laboratory divisions were developed in 1982.

The presentations of education and training programs by Industrial Safety and Special Projects Section staff have always been recognized as an important part of the safety effort at the Laboratory. Defensive driving, hazard-potential recognition, supervisor development, and orientation for new employees are some of the programs now under way.

During 1982, 34 Laboratory employees participated in the National Safety Council's Defensive Driving Course and 19 in the Supervisors' Development Program. In addition, new employee safety orientation was provided for 80 employees.

The ORNL safety staff participated in a variety of professional development training activities. Development of a videotape on the ORNL safety program was completed. Six new safety films, eight slide shows, and one videotape were obtained for the visual aids library. The section initiated a program of providing industrial safety internships for graduate students from The University of Tennessee.

The section experienced three separate audits or inspections conducted by representatives of the DOE or UCC-ND Office of Health, Safety, and Environmental Affairs. The results of these reviews are as follows:

- The UCC-ND Safety and Health Audit, which was conducted in February 1982, recognized ORNL for administering effective and innovative safety and health programs consistent with UCC, DOE, Nuclear Division, and Laboratory requirements and noted several procedural errors for which corrective action was immediately initiated.
- The DOE Industrial and Construction Safety Appraisal, which was conducted April 16–30, 1982, resulted in a Superior rating.
- The DOE Occupational Safety and Health Inspection, which was conducted September 29, 1982, resulted in no conditions posing imminent danger. Two violations identified during the inspection were posted, and immediate corrective actions were initiated.

5.1.2 Construction Safety

Special emphasis on construction safety continued during 1982. Several safety training sessions were held with ORNL Construction Engineers to help them better recognize safety problems on the work site. These sessions covered subjects such as protective equipment, falling hazards, safety awareness, and steel construction.

Formal, documented site inspections with the Construction Engineers were supplemented by informal site visits. Prompt corrective action was emphasized when deficiencies were noted. Participation in preconstruction meetings and review of engineering designs and specifications were also part of the construction safety effort.

5.1.3 Off-the-Job Safety

An ORNL Off-the-Job Safety Action Plan was developed to formalize efforts under way to reduce off-the-job injuries, which result in pain and suffering to employees and a large economic loss to the Laboratory. Off-the-job safety was emphasized through safety bulletins, quarterly safety meetings, and new visual aids and promotional literature. The National Safety Council's quarterly publication of *Family Safety Magazine* was mailed to the home of each ORNL employee. Off-the-job safety will continue to receive strong emphasis as part of the Laboratory's overall safety program.

5.1.4 Safety Performance

The continuing emphasis on safety during CY 1982 has resulted in significant improvements in the ORNL safety program. Through the combined efforts of all employees, ORNL safety performance was better than all CY-1982 on-the-job injury and illness goals as shown in the following comparison table:

	Lost-work-day cases		Recordable injuries and illnesses	
	Number	Incidence rate	Number	Incidence rate
1982 (Actual)	1	0.02	24	0.59
1982 (Control)	2	0.05	39	0.90

Through December 31, 1982, the Laboratory had worked 198 days and accumulated 4,256,647 exposure-hours since the last lost work-day case.

The off-the-job safety program was expanded in CY 1982 by devoting more safety meetings to the subject. In these meetings, films purchased from outside sources, internally created videotapes, and talks about personal experiences were presented. Additionally, information on off-the-job accident prevention continued to be distributed to employees as handouts in safety meetings and through direct mailing to each employee's home.

	Off-the-job disabling injuries	Off-the-job frequency rate
1982 (Actual)	57	3.40
1982 (Control)	55	3.28

A comparison of UCC-ND on-the-job lost-work-day and recordable injury and illnesses cases is shown in Tables 5.1 and 5.2, respectively.

The Laboratory earned the following awards for safety performance in 1982:

- The UCC Gold Award for Outstanding Safety Performance for operating 16,000,000 employee-hours without a lost work day case from May 11, 1980 through June 16, 1982. The total hours worked during this period was 17,907,911—a new ORNL, Nuclear Division, and UCC record.
- The NSC Award of Honor for the eighth consecutive year (NSC's highest award).
- The DOE Award of Excellence for maintaining the incidence rate of lost work days and restricted work cases below 1.1 for five consecutive years.

Continued outstanding safety performance contributed to a reduced workmen's compensation premium being paid by ORNL. Improved safety performance over the past three years has saved ORNL over $980,000 in premium payments based upon the CY 1979 premium rate.

Employees throughout the Laboratory demonstrated a very positive attitude toward safety; and with this type of continued attitude and effort, ORNL will stay well below our control limits for 1983.

Table 5.1. UCC-ND comparison of on-the-job lost-work-day cases and incidence rates

Site	1978		1979		1980		1981		1982	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No.	Rate
ORNL	3	0.07	3	0.07	2	0.05	0	0.00	1	0.02
Y-12	3	0.05	2	0.03	1	0.02	2	0.03	2	0.03
ORGDP	5	0.09	0	0.00	2	0.04	1	0.02	1	0.02
PGDP	1	0.04	1	0.05	2	0.11	0	0.00	0	0.00

Table 5.2. UCC-ND comparison of recordable injuries and illnesses and incidence rates

Site	1978		1979		1980		1981		1982	
	No.	Rate	No.	Rate	No.	Rate	No.	Rate	No	Rate
ORNL	59	1.40	44	1.05	41	0.96	41	0.95	24	0.59
Y-12	75	1.29	56	0.91	80	1.25	53	0.86	66	0.96
ORGDP	82	1.40	72	1.25	55	0.98	49	0.96	25	0.59
PGDP	46	2.05	36	1.75	25	1.34	19	1.19	18	1.38

5.2 OFFICE OF OPERATIONAL SAFETY

The Office of Operational Safety (OOS) serves as the focal point for the operational safety activities (including reactor and criticality safety) at ORNL and provides liaison between ORNL; UCC-ND Health, Safety, and Environmental Affairs Office; and DOE-Oak Ridge Operations on operational safety matters. The primary responsibilities of the office are coordinating and monitoring the activities of the DSOs, RCOs, and the Laboratory Director's Review Committees and ensuring follow-up of Committee recommendations. The staff also participates in a wide variety of operational and radiation safety matters including development of safety policies, procedures, practices, and guidelines for various Laboratory operations. Through review and approval functions, the office provides assurance to management that Laboratory safety requirements are included in the design, modification, and construction of facilities and that all facilities, including reactors, are operated safely in accordance with ORNL and DOE requirements. The director of the office serves as the Laboratory's safety documentation and review coordinator in accordance with Standard Practice Procedure D-5-29. In fulfilling this responsibility, the director and the staff provide coordination, direction, and approval of safety documentation to ensure compliance with Laboratory and DOE requirements. The office additionally provides coordination of safety activities in the decontamination and decommissioning program to ensure that all environmental, safety, and health physics concerns are included. A recently added function is that of coordinating the Unusual Occurrence Reporting (UOR) System at the Laboratory to ensure that it operates in a meaningful way and meets Laboratory and DOE requirements.

5.2.1 Laboratory Director's Review Committees

One of the most important means that the Laboratory has to ensure the continued safe operations of its many facilities is through the activities of the ORNL Laboratory Director's Review Committees. The OOS continued to coordinate committee activities in 1982 to assure that the expertise represented by the committees was applied to the review of facilities and operations in a manner to provide Laboratory management with a factual, independent assessment of the safety aspects of these operations. The OOS coordinated the work of the Radioactive Operations Committee, Reactor Operations Review Committee, Reactor Experiments Review Committee, Criticality Committee, High-Pressure-Equipment Review Committee, Transportation Committee, Accelerators and Radiation Sources Review Committee, and Electrical Safety Committee. These committees are responsible for review and recommendations for operations with significant or unique hazards.

In the coordinating role, OOS is responsible for ensuring that safety concerns are properly brought before the committees and that necessary reviews are scheduled. It is also responsible for participating in reviews as ex officio committee members, finalizing reports documenting reviews, and ensuring that recommendations formulated as a result of the reviews are either implemented or resolved in a manner satisfactory to management.

In 1982, the committees conducted 64 meetings, including 5 with the Laboratory's Executive Director. It is established procedure for the committees to meet annually with the Executive Director to discuss their respective work for the year and issues not necessarily covered in formal committee reports. Because scheduling problems prevented meetings of all committees with the Executive Director in 1982, the remaining committees will meet with the Executive Director in 1983.

5.2.2 DSO-RCO Activities

In addition to the Laboratory Director's Review Committees, another very important means that the Laboratory uses to ensure continued safe operation of the Laboratory's facilities is that of utilizing the services of DSOs and RCOs. The officers have the primary responsibility for coordinating safety and radiation safety, respectively, within their divisions. A current listing of DSOs and RCOs and the divisions they represent is presented in Table 5.3.

The OOS coordinates the activities of DSOs and RCOs and conducts quarterly meetings to disseminate information of interest and importance to them. During 1982, meetings were conducted on February 9, April 19, July 28, and October 13. The meetings were documented, respectively, in ORNL/CF-82/35, ORNL/CF-82/75, ORNL/CF-82/239, and ORNL/CF-82/295. The OOS also reviews and comments on Safety Analysis Reports (SARs), Project Safety Summaries, safety inspections, and reports of accidents submitted by the safety officers. It also reviews operations for recommendation and approval, the requirements of which are not specifically covered in manuals.

5.2.3 ORNL Safety Analysis and Review Program

The history of the Laboratory's formal safety analysis and review program, which was first established under the Energy Research and Development Administration in 1977 and subsequently refined and expanded under DOE, was presented in the 1981 annual report. The current DOE Orders stipulating the requirements for this program are DOE and DOE-ORO Orders 5481.1A and OR 5481.1A issued in August 1981 and June 1982, respectively. (It should be noted that the Laboratory had a safety analysis and review program in operation for many years prior to the formal DOE Order requirement—although not in the strictly documented sense now specified by DOE.) In addition, the detailed requirements of the program as it applies to the Nuclear Division are found in Standard Practice Procedure D-5-29, "Safety Review and Documentation Program," with ORNL requirements contained in a supplementary procedure D-5-29S, with the same title. As in the beginning of the pro-

Table 5.3. Division safety officers and radiation control officers

Division	Name
Analytical Chemistry	R. E. Jones, RCO
	A. L. Harrod, DSO
Biology	J. A. Otten, DSO, RCO
Chemical Technology	C. D. Watson, DSO, RCO
	F. A. Kappelmann, Alternate
Chemistry	C. E. Haynes, DSO, RCO
	W. D. Carden, Alternate
Computer Sciences	J. M. Barnes, DSO, RCO
Central Management	G. C. Cain, DSO
Employee Relations	J. A. Holloway, DSO
Energy	C. M. Haaland, DSO, RCO
Engineering	A. D. Johnson, DSO, RCO
Engineering Technology	C. A. Mills, DSO
	R. B. Gallaher, Associate DSO
	A. W. Longest, RCO
Engineering Physics and ORELA	R. R. Spencer, DSO, RCO
	S. L. Rider, Alternate
Environmental Sciences	M. H. Shanks, DSO, RCO
Finance and Materials	G. E. Testerman, DSO
Fuel Recycle	D. E. Dunning, DSO, RCO
Fusion Energy	W. C. Brock, Jr., DSO, RCO
	G. F. Bowles, Alternate
Health	J. A. Ealy, DSO, RCO
	W. E. Porter, Alternate
Health and Safety Research	F. R. O'Donnell, DSO, RCO
Industrial Safety and Applied Health Physics	R. E. Millspaugh, DSO
	A. J. Smith, RCO
Information	E. J. Howard, Sr., DSO
	A. J. Shelton, DSO
Instrumentation and Controls	E. M. Robinson, DSO, RCO
Laboratory Protection	R. L. Atchley, DSO
	H. C. Austin, RCO
Metals and Ceramics	W. H. Miller, Jr., DSO, RCO
	E. S. Bomar, Assoc. RCO
Operations	D. W. Ramey, DSO, RCO
Physics	K. S. Toth, DSO, RCO
Plant and Equipment	R. H. Winget, DSO, RCO
Quality Assurance and Inspection	J. L. Holbrook, DSO, RCO
	R. G. Pope, Alternate
Solid State	R. R. Coltman, DSO
	H. R. Child, RCO

gram, the Director of OOS is the designated Laboratory coordinator and is responsible for coordinating safety analysis activities. The coordination activities require a considerable effort from the entire office staff and consume much of their working time. The staff provides guidance to document writers, reviews document drafts, arranges and ensures committee review of documents, serves as liaison with the DOE-ORO safety staff during the document review and approval process, ensures document completion, prepares document transmittals for management approval, and maintains a file of completed documents.

Since the beginning of the program in FY 1977 through FY 1982, 12 documents for existing facilities have been written and submitted to DOE-ORO for review and approval. Four of these have been approved. The cost for existing facility documents through FY 1982 was $1,000,000—with $244,000 spent during FY 1982.

In addition to documents for existing facilities, documents for the following four new facilities were completed through FY 1982: Holifield Heavy Ion Facility, 3027 Nuclear Materials Storage Vault, New Hydrofracture Facility, and the Gunite Tank Project. Documents for two of these facilities (Hydrofracture and Gunite Tank) were completed in FY 1982; the other two documents had been completed previously. The SARs for these facilities were produced by the Engineering Division as is the case for all new or modified facilities. The costs for these documents were borne by the project.

By the end of FY 1983, the Laboratory expects that 17 documents out of 20 originally scheduled will be completed and approved. After FY 1983, it is estimated that 11 documents [SARs and Occupation Safety Requirements (OSRs)]; 50 Safety Assessments; and, if DOE requires, eight accelerator documents will remain to be completed.

5.2.4 Staff Consultation, Review, and Other Activities

To fulfill the major responsibility of assuring management of continued safe operation of Laboratory facilities, OOS engages in activities in addition to those previously described. The office staff processed numerous requests for approval of proposed experiments and operations including the handling and processing of special radioactive materials, the disposal of radioactive waste, and the transportation of nuclear materials.

Other staff activities included participating in accident and near-miss investigations and planning and assisting in performing emergency drills and observing drills. The staff also participates in and develops procedures for the *ORNL Health Physics Manual, ORNL Safety Manual,* and the *Standard Practice Procedures Manual.*

Considerable assistance was again provided in 1982 to Laboratory staff in the design and procurement of glove boxes. Assistance has continued to the Engineering Division staff in establishing criteria for polycarbonate glove-box windows. The staff additionally provided assistance in reviewing decontamination and decommissioning (D&D) criteria, in setting priorities for D&D work, and in planning and executing D&D activities. Specific D&D activities included planning and executing radiological characterization for Building 3505 and following the 3039 off-gas and cell-ventilation system upgrading work. Review of the planned isotope-area-ventilation system upgrading was also performed to ensure the adequacy of proposed modifications.

In exercising the responsibility for providing liaison between management and DOE on operational safety matters, a number of meetings were held with DOE-ORO safety staff. Included in the meetings was participation in the following:

- DOE Emergency Preparedness Appraisal of ORNL, September 7–October 8, 1982.
- DOE 1982 Reactor Safety Appraisal of ORNL, November 1982
- DOE Annual Health Physics Appraisal, February 1982
- DOE Annual Environmental Management Appraisal, October 1982

The OOS's responsibilities in audits also include ensuring follow-up of audit recommendations and providing implementation progress reports when required. The OOS also participated in the UCC-ND 1982 Safety and Health Audit of ORNL, which included audits of industrial and operational safety, industrial hygiene, and the Laboratory's Safety Analysis and Review Program required by DOE. The OOS Director also served as a member of the UCC-ND audit team reviewing the Safety Analysis and Review Program at the Paducah plant.

5.2.5 Unusual Occurrence Reporting (UOR) System

The OOS was assigned the new responsibility in 1982 of coordinating the Laboratory's UOR Program. In accordance with this responsibility, the OOS coordinated the preparation of several UORs by operating division, reviewed the reports for compliance with DOE and ORNL requirements, and prepared report transmittals for management approval. The OOS subsequently followed the implementation of corrective action required in the reports and prepared quarterly summaries of reports generated and/or closed out during the quarter for ORNL, UCC-ND, and DOE management.

5.2.6 Summary

During 1982, there were no facility or nuclear reactor accidents or incidents of an operational nature which resulted in injury to personnel or which were reportable to DOE, other than as UORs or quality assurance (QA) deficiency reports. However, there was one exposure incident caused by personal action in which no process failure or malfunction was involved but which did result in a DOE-mandated Type B board investigation.

The OOS staff continued consultation, review, and approval of numerous concerns and requests involving operational matters presented by Laboratory facility staffs. The OOS continued to review and ensure review of facilities and operations by appropriate Director's Committees to ensure management of continued safe operation of those facilities and operations.

Work continued on implementing the existing facility safety documentation program requirements of DOE. The following three new facilities were reviewed and approved for operation, including approval of all safety documentation: the New Hydrofracture Facility, the Gunite Tank Project, and the Holifield Heavy Ion Facility. The effort continued in developing criteria for D&D work, carrying out radiological characterization work, and establishing D&D priorities for surplus facilities was completed. The added responsibility for coordinating the Laboratory's UOR program was begun in mid-year.

6. Presentation of Technical Results

6.1. PRESENTATIONS AND LECTURES

W. A. Alexander, "The Use of DOE/RECON in Environmental Protection," 1982 UCC-ND and GAT Waste Management Seminar, Gatlinburg, Tenn., Apr. 5–7, 1982.

W. A. Alexander, T. W. Oakes, W. F. Ohnesorge, and H. M. Hubbard, "Site Characterization of Soil in Preparation for Decontamination and Decommissioning," 27th Annual Meeting of the Health Physics Society, Las Vegas, Nev., June 27–July 1, 1982.

W. A. Alexander, T. W. Oakes, W. F. Ohnesorge, and H. M. Hubbard, "Site Characterization of Soil in Preparation for Decontamination and Decomissioning," East Tennessee Chapter Health Physics Society, Oak Ridge, Tenn., July 2, 1982.

W. A. Alexander, "Environmental Management at the Oak Ridge National Laboratory," East Tennessee Chapter of the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Knoxville, Tenn., Dec. 16, 1982.

J. D. Allen, Jr., B. A. Kelly, C. K. Johnson, and T. W. Oakes, "The Spills Problem and Applied Artificial Intelligence," 1982 UCC-ND and GAT Waste Management Seminar, Gatlinburg, Tenn., Apr. 5–7, 1982.

J. A. Attrill, B. R. Clark, H. G. Davis, B. M. Eisenhower, and J. H. Stewart, Jr., "Industrial Oil Spill Identification Procedure at Oak Ridge National Laboratory," National American Chemical Society Meeting, Las Vegas, Nev., March 1982.

J. A. Auxier, "Health Effects of Low-Level Radiation," 9th Annual WATTec Energy Conference, Knoxville, Tenn., Feb. 26, 1982.

J. A. Auxier, "Radiation Dosimetry," lecture for Personnel Radiation Dosimetry Course, DOSAR Facility, ORNL, Oak Ridge, Tenn., Apr. 1, 1982.

J. A. Auxier, "Future of Health Physics," ORAU Training Program, Oak Ridge, Tenn., Apr. 2, 1982.

J. A. Auxier, "Implications of Recently Proposed Revisions of Doses for Hiroshima and Nagasaki Survivors," Continuing Education Course, Health Physics Society Annual Meeting, Las Vegas, Nev., June 29, 1982.

J. A. Auxier, "A Viewpoint on Proposed Radiation Protection Standards," Atomic Industrial Forum's Conference on Radiation Issues for the Nuclear Industry, New Orleans, La., Oct. 4, 1982.

J. A. Auxier, "Protection of the Public from Nuclear Energy Installations," Speakers Bureau Seminar, Oak Ridge, Tenn., Oct. 15, 1982.

J. A. Auxier, "Biological Perspective of Regulatory Standards," lecture for Personnel Radiation Dosimetry Course, Oak Ridge, Tenn., Nov. 11, 1982.

J. A. Auxier, "An HP Look at DeMinimis," NRC meeting, Washington, D.C., Nov. 12, 1982.

J. A. Auxier, "Environmental Monitoring: What We Have Learned in the Past Forty Years," Environmental Monitoring Mini Symposium, Upton, N.Y., Dec. 8, 1982.

C. D. Berger, "Bioassay," REAC/TS Training Program, Oak Ridge, Tenn., Jan. 12, 1982.

C. D. Berger, "Whole Body and Lung Counting," ORAU Training Program, Oak Ridge, Tenn., Feb. 18, 1982.

C. D. Berger, "Laboratory Assessment of Body Burden," REAC/TS Training Program, Oak Ridge, Tenn., Mar. 10, 1982.

C. D. Berger, "Radiation Monitoring," REAC/TS Training Program, Oak Ridge, Tenn., Mar. 17, 1982.

C. D. Berger, "HpGe for In-Vivo Detection of the Actinides," ORTEC Workshop on Germanium Detectors, Oak Ridge, Tenn., Apr. 1, 1982.

C. D. Berger, "Whole Body Counting," ORAU Training Program, Oak Ridge, Tenn., June 2, 1982.

C. D. Berger, "Laboratory Assessment of Body Burden," REAC/TS Training Program, Oak Ridge, Tenn., Aug. 25, 1982.

C. D. Berger, "Radiation Monitoring," REAC/TS Training Program, Oak Ridge, Tenn., Aug. 26, 1982.

C. D. Berger, "Monitoring Devices and Their Use," REAC/TS Training Program, Oak Ridge, Tenn., Sept. 8, 1982.

C. D. Berger, "Bioassay," REAC/TS Training Program, Oak Ridge, Tenn., Sept. 21, 1982.

C. D. Berger, "Bioassay and Whole Body Counting," ORNL NRRPT Review Course, Oak Ridge, Tenn., Sept. 29, 1982.

C. D. Berger, "Whole Body Counting," ORAU Training Program, Oak Ridge, Tenn., Oct. 20, 1982.

C. D. Berger, E. E. Watson (ORAU), B. H. Lane, and T. Hamrick, "Long-Term Retention of Thallium-202 in a Patient after Thallium-201 Administration," 23rd Annual Meeting of the Southeastern Chapter of the Society of Nuclear Medicine, Charlotte, N.C., Oct. 27–30, 1982.

C. D. Berger, "Monitoring Devices and Their Use," REAC/TS Training Program, Oak Ridge, Tenn., Nov. 16, 1982.

J. T. Blackmon, Jr., "Hotel and Motel Fire Safety," Annual Meeting of the American Alliance for Health, Physical Education, Recreation, and Dance, Houston, Tex., May 1982.

J. T. Blackmon, Jr., "Hazards Recognition for the Bench Experimentalist," National Safety Congress Seminar, Chicago, Ill., October 1982.

H. M. Braunstein, B. M. Eisenhower, and W. G. Dreibelbis, "PAH-Contaminated Materials Management at Oak Ridge National Laboratory," 7th International Symposium on Polynuclear Aromatic Hydrocarbons, Columbus, Ohio, Oct. 26–28, 1982.

H. M. Braunstein, D. J. Pack, and T. W. Oakes, "Intercomparison of Stable Element Content of Food by Statistical Methods," Annual Conference on Trace Substances in Environmental Health, Columbus, Ohio, June 1–3, 1982.

H. M. Butler, "Interaction Management Training Course," ORNL, Oak Ridge, Tenn., March–May 1982.

D. P. Carnes and S. R. Blum, "Computerized Management of National Pollutant Discharge Elimination System (NPDES) Data at Oak Ridge National Laboratory," 1982 UCC-ND and GAT Waste Management Seminar, Gatlinburg, Tenn., Apr. 5–7, 1982.

R. E. Coleman, "Purpose and Use of Radiation Survey Instruments," Plant and Equipment Division personnel, ORNL, Oak Ridge, Tenn., April 1982.

R. E. Coleman, "Health Physics Procedures and Instruments," Plant and Equipment and Instrumentation and Controls divisions personnel, ORNL, Oak Ridge, Tenn., June 1982.

R. E. Coleman, "Radiation Detection Instruments," lecture to ORNL HFIR personnel, Oak Ridge, Tenn., August 1982.

R. E. Coleman, "Facility Specific Information," ORNL, Oak Ridge, Tenn., Sept. 2, 1982.

K. L. Daniels, J. C. Goyert, R. H. Strand, and M. P. Farrell, "A General Linear Models Approach for Comparing the Response of Several Species in Acute Toxicity Tests," 7th Annual SAS Users Group International Conference, San Francisco, Calif., Feb. 14–17, 1982.

K. L. Daniels, J. C. Goyert, R. H. Strand, and M. P. Farrell, "A General Linear Models Approach for Comparing the Response of Several Species in Acute Toxicity Tests," Environmental Sciences Division Annual Information Meeting, ORNL, Oak Ridge, Tenn., May 10–11, 1982.

K. L. Daniels, "Statistical Analysis for Structure—Activity Relationships," Joint Meeting of the American Society for Pharmacology and Experimental Therapeutics and the Society of Toxicology, Louisville, Ky., Aug. 17, 1982.

H. W. Dickson, "Criticality and Associated Dose Estimates," REAC/TS Course—Health Physics in Radiation Accidents, ORAU, Oak Ridge, Tenn., Jan. 12, 1982.

H. W. Dickson, "Overview of Personnel Radiation Dosimetry," lecture for Personnel Radiation Dosimetry Course, DOSAR Facility, ORNL, Oak Ridge, Tenn., Mar. 29, 1982.

H. W. Dickson, "Criticality and Fission," NRRPT Certification, ORAU, Oak Ridge, Tenn., Sept. 8, 1982.

H. W. Dickson, "Criticality and Associated Dose Estimates," REAC/TS Course—Health Physics in Radiation Accidents, ORAU, Oak Ridge, Tenn., Sept. 21, 1982.

H. W. Dickson, "Japanese Methods for Productivity and Quality," ORNL, Oak Ridge, Tenn., Sept. 27–Oct. 1, 1982.

H. W. Dickson, "Overview of Personnel Radiation Dosimetry," lecture for Personnel Radiation Dosimetry Course, DOSAR Facility, ORNL, Oak Ridge, Tenn., November 1982.

B. M. Eisenhower and T. W. Oakes, "Hazardous Material Management and Control Program at ORNL—Environmental Protection," 1982 UCC-ND and GAT Waste Management Seminar, Gatlinburg, Tenn., Apr. 5–7, 1982.

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M. F. Fair, "Health Physics," lecture presented at WATTec Conference, Knoxville, Tenn., February 1982.

M. F. Fair, "Health Physics," lecture presented to Junior Sciences and Humanities Symposium, ORNL, Oak Ridge, Tenn., March 1982.

M. F. Fair, "Health Physics," lectures to members of Industrial Hygiene Department, ORNL, Oak Ridge, Tenn., May 1982.

M. F. Fair, Proctor for the American Board of Health Physics Certification Examination, Oak Ridge, Tenn., June 1982.

M. F. Fair, "Health Physics," lectures to members of Environmental Management Department, ORNL, Oak Ridge, Tenn., August 1982.

M. F. Fair, "Health Physics," lecture to NRRPT Training Course, ORNL, Oak Ridge, Tenn., August 1982.

M. F. Fair, "Health Physics," lecture to class at ORAU, Oak Ridge, Tenn., September 1982.

M. F. Fair, "Health Physics," lecture to members of Analytical Chemistry Division, ORNL, Oak Ridge, Tenn., October 1982.

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W. F. Ohnesorge, D. P. Carnes, and R. L. Haese, "Preparation of Computer Data Bases for Environmental Protection," 1982 UCC-ND and GAT Waste Management Seminar, Gatlinburg, Tenn., Apr. 5–7, 1982.

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M. T. Ryan, H. M. Butler, E. D. Gupton, and C. S. Sims, *Calibration of the Indium Foil Used for Criticality Accident Dosimetry in the UCC-ND Employee Identification Badge,* ORNL/TM-8294, Union Carbide Corp. Nuclear Div., Oak Ridge Natl. Lab., May 1982.

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6.3. IS&AHP LUNCHEON SEMINARS

"New Recommendations of ICRP—Internal Dose," M. T. Ryan, June 17, 1982.

"A Radon-Immune Air Monitor for Plutonium," E. D. Gupton, June 18, 1982.

"A Review of DOE/ORNL Off-site Emergency Response Capability," T. W. Oakes, July 16, 1982.

"A Review of DOE Effluent Monitoring and Atmospheric Dose Guidelines," T. W. Oakes, Aug. 24, 1982.

6.4. PROFESSIONAL ACTIVITIES AND ASSOCIATIONS

J. A. Auxier, consultant to Radiation Effects Research Foundation, Japan; member, Dose Assessment Steering Group, U.S. Department of Energy; advisor, U.S. Department of Justice on Health Physics and Radiation Dosimetry; member, National Academy of Sciences Panel on Hiroshima/Nagasaki Occupation Forces; member, Subcommittee on Exposure at Tests of Nuclear Weapons, National Academy of Sciences; member, National Council on Radiation Protection and Measurements; member, Health Physics Society; member, Awards Committee, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, NCRP Scientific Committee 34 on Maximum Permissible Concentrations for Occupational and Non-Occupational Exposure; member, NCRP Scientific Committee 57 on Internal Emitter Standards; member, NCRP Scientific Committee 63 on Radiation Exposure Control in Peacetime and Wartime; member, The Safety Advisory Board for Three Mile Island, Unit 2; member, National Academy of Sciences Committee on Emergency Management; member, Advisory Council, Institute of Nuclear Power Operations.

J. F. Alexander, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.

W. A. Alexander, member, Health Physics Society; member and area representative, East Tennessee Chapter Health Physics Society; member, WATTec symposia and meeting, program, public information, publicity, and sponsor committees.

B. D. Barkenbus, member, American Chemical Society; member, East Tennessee Chapter Health Physics Society.

C. D. Berger, member, Sigma Xi; member, American Association of Women in Science; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; charter member, San Diego Chapter Health Physics Society.

J. T. Blackmon, Jr., member, American Alliance for Health and Safety; member, American Public Health Association; member, American School and Community Safety Association; member, National Fire Protection Association; member, National Safety Council Certificate of Achievement—1982; member, National Safety Management Society; member, Society of Fire Protection Engineers (national and local).

H. M. Braunstein, member, American Chemical Society; member, American Industrial Hygiene Association; member, Tennessee Valley Section Industrial Hygiene Association; member, American Public Health Association; member, East Tennessee Chapter Health Physics Society; member, Sigma Xi; certification as Registered Professional Environmentalist—State of Tennessee, Mar. 18, 1982.

J. S. Brown, member, East Tennessee Chapter American Society of Safety Engineers.

G. H. Burger, member, East Tennessee Chapter Health Physics Society; member, American Nuclear Society; member, Instrument Society of America.

H. M. Butler, member, Health Physics Society; chairman, Admissions Committee, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, Advisory Committee on Nuclear Technology, Chattanooga State Community College; member, Nomination and Awards Committee, East Tennessee Chapter Health Physics Society.

B. A. Campbell, member, East Tennessee Chapter Health Physics Society.

T. T. Clark, member, American Society of Clinical Pathologists.

K. L. Daniels, member, American Fisheries Society; member, American Statistical Association; member, Beta Beta Beta; member, Phi Kappa Phi.

S. DeLaGarza, member, East Tennessee Chapter Health Physics Society.

D. T. Dice, member, American Nuclear Society Committee 15.14, Physical Security of Research Reactors; member, Health Physics Society.

H. W. Dickson, member, Health Physics Society; treasurer, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, International Radiation Protection Association; member, Radiation Research Society.

B. M. Eisenhower, member, American Industrial Hygiene Association; member, American Society of Safety Engineers; member, American Society for Testing and Materials and ASTM Committee D-34; member, East Tennessee Chapter American Society of Safety Engineers; member, East Tennessee Chapter Health Physics Society.

J. S. Eldridge, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.

M. F. Fair, member, East Tennessee Chapter Health Physics Society.

E. D. Gupton, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, Sigma Pi Sigma; member, National Honorary Physics Society.

S. F. Huang, member, East Tennessee Chapter Health Physics Society.

H. M. Hubbard, member, East Tennessee Chapter Health Physics Society; organizing chairman/president of the Student Chapter of the American Society of Safety Engineers.

L. L. Huey, member, East Tennessee Chapter American Society of Safety Engineers.

B. A. Kelly, member, Chi Epsilon; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; Professional Engineer's Registration—1982, Health Physics Certification (Comprehensive)—American Board of Health Physics—1982.

M. W. Knazovich, member, East Tennessee Chapter American Society of Safety Engineers.

R. E. Millspaugh, member, East Tennessee Chapter Health Physics Society.

M. A. Montford, member, East Tennessee Chapter Health Physics Society; member, International Toastmistress Conference.

E. A. Moore, member, East Tennessee Chapter Health Physics Society.

J. R. Muir, member, Health Physics Society; chairman, Rules Committee 1981–1982, Health Physics Society; member, Association of Records Managers and Administrators; member, East Tennessee Chapter Health Physics Society; member, American Industrial Hygiene Association.

T. W. Oakes, member, American Society for Testing and Materials; member, American Industrial Hygiene Association; member, American Nuclear Society; member, Health Physics Society: member, Ad Hoc Committee, "Formation of Environmental Section"; session chairperson, Operational Health Physics Session, Annual Meeting; and technical Reviewer for *Health Physics Journal;* member, East Tennessee Chapter Health Physics Society: chairperson, WAT-Tec Sponsors' Committee; member, Program Committee; and chairperson, Midyear and Annual Meeting Committee; member, American Association for Advancement of Science; member, The New York Academy of Sciences; member, The International Certified Hazard Control Manager; member, American Society of Professional Ecologists; member, American Society of Safety Engineers.

W. F. Ohnesorge, member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.

R. K. Owenby, member, East Tennessee Chapter Health Physics Society.

D. W. Parsons, member, East Tennessee Chapter Health Physics Society.

M. T. Ryan, certification in Comprehensive Practice of Health Physics by the American Board of Health Physics, October 1982; Ph.D. in Health Physics from the Georgia Institute of Technology, 1982; member, Sigma Xi; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society; member, American Industrial Hygiene Association.

D. B. Slaughter, member, East Tennessee Chapter Health Physics Society.

E. B. Wagner, member, American Radio Relay League; member, Health Physics Society; member, East Tennessee Chapter Health Physics Society.

A. C. Wittmer, member, East Tennessee Chapter Health Physics Society; Professional Secretaries International—Oak Ridge Chapter, Certified Professional Secretary (CPS)—1982.

6.5. AWARDS

M. F. Fair, 1982 Distinguished Service Award of the East Tennessee Chapter Health Physics Society.

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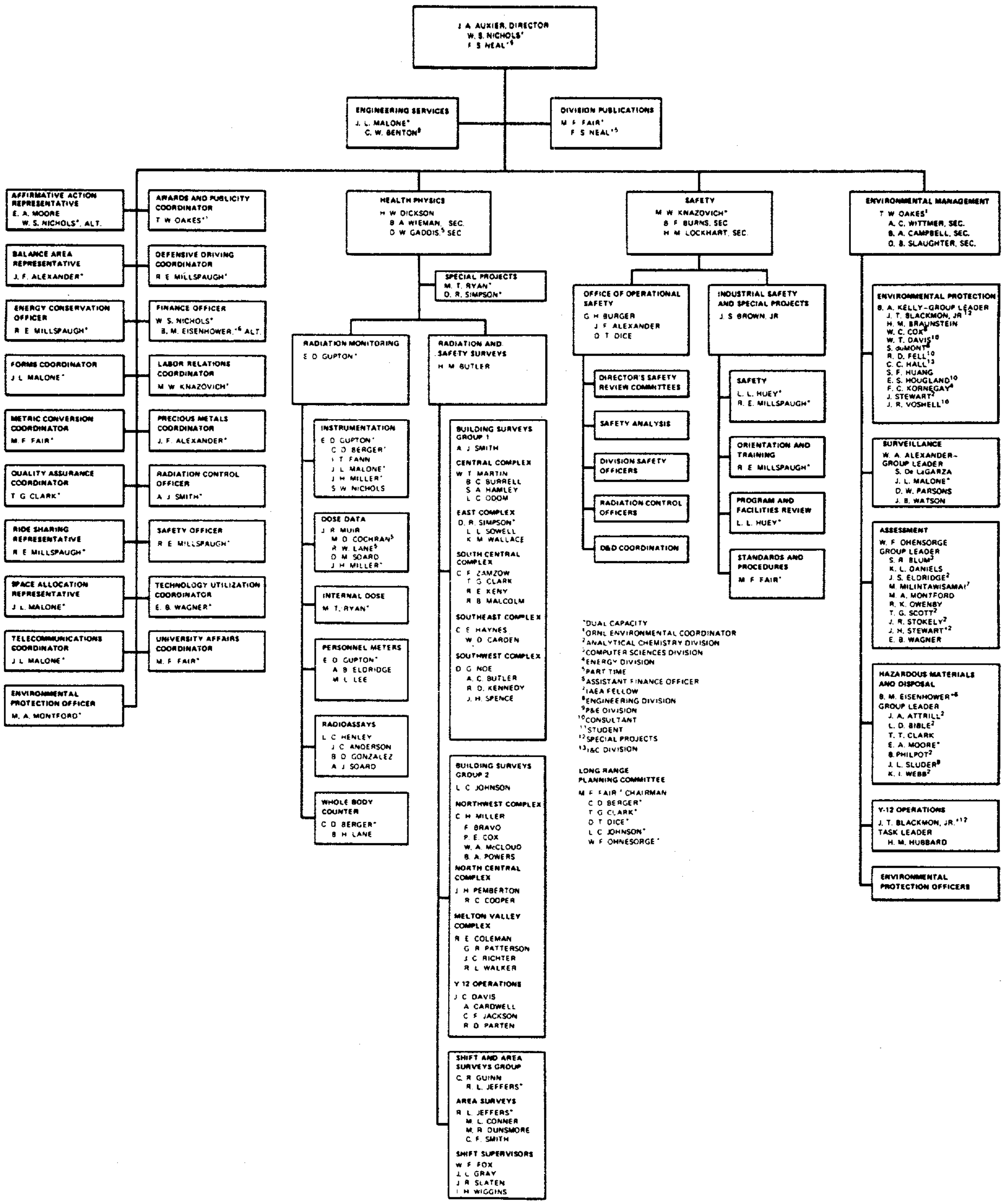

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